POWER

Volume 54 New York, July 19, 1921 *Number* 3

Have a Heart!

IT is hot. Even in your shaded office, Mr. Manager or Chief Engineer, with open windows and humming fan you can hardly compel your interest in your work to overcome the lethargy induced by physical discomfort.

Do you want to cool off? Take a stroll down to the engine room, the boiler plant, two or three stories under ground maybe. No open window and probably no desk fan here, and if there were it could only circulate the stifling air, hot from radiating pipes and cylinders and boiler settings, humid with seeping steam and rank with the smell of heated oil. Men, your men, have to work in it all day. And they have to keep up their vigilance against interruption and their interest in the processes that they are conducting in order that your business may go on in safety without shut-down or impairment of efficiency They cannot take an afternoon off when the heat gets unbearable — it must not get unbearable for them. The most that they can do is to steal occasionally to a corner where there is an indraft of the outdoor air and brace themselves for another spell of application.

True, men must work in hot and uncomfortable surroundings if industry is to go on, but have you done everything that you can to relieve the discomfort? A liberal use of nonconducting covering upon the hot surfaces will not only reduce the temperature several degrees, but will soon pay for itself in the saving of the heat units which now add to the discomfort. Have you given the same intelligent study to the ventilation of the place that you would if you had to pass any considerable portion of your time there? A well-placed exhaust fan and ventilating flue might work wonders.

Do you provide plenty of cold, healthful drink and bathing facilities? You know how grateful that cold shower is when you come in hot, perspiring and tired from a round of golf. Have you considered the practicability of putting on a relief during an exceptionally hot spell and giving each man an occasional break, if only for a half day in his sweltering toil?

If you would do these things, your men would rise up and call you blessed, you would have the pick of skilled labor and you would get more and better work for the same money, besides the satisfaction of having made life more bearable for those whose conditions have been placed in your keeping.

F. R. Low.

RAINFALL and STREAM FLOW

By N. L. Devendorf*

Rainfall in different sections of the country and the proportion available in stream flow for power purposes. Gaging a stream; the importance of studying its characteristics; estimating the flow available from past records and advance information from upstream and over the complete area of the watershed.

EVAPORATION from the ocean and other large bodies of water takes place from the action of the heat of the sun. The resulting vapors are driven by the winds over the land in the form of clouds, which condense into water as soon as cooled below the point of saturation, falling to the ground in the form of rain or snow.

Owing to varying physical and topographical conditions some localities have a greater rainfall than others. The average precipitation in the United States, according to the records of the Weather Bureau, is 29.4 in. annually. The Great Lakes basin has from 30 to 40 in.; the New England and Appalachian regions, 40 to 50 in.; the Southern States, 50 to 60 in., and a limited area on the eastern slope of the Blue Ridge along the Gulf Coast, 60 to 70 in. A section from Minnesota south through Texas has 20 to 30 in. From this region west to the Rocky Mountains much of the country is semi-arid, with an annual rainfall of 10 to 20 in. The desert region of the Southwest holds the record for aridity, with a precipitation of less than 3 in., while the heaviest rainfall in this country occurs in the Puget Sound region, where the annual average is 80 to 100 in. The rainfall of the Pacific Coast diminishes from this high figure to 22 in. at San Francisco and to about 10 in. at San Diego. An inch of rainfall amounts to 113 tons of water to the acre. It will be seen that the volume of water falling on a watershed of several hundred miles will run into large figures. Part of this total is disposed of by evaporation, part by surface drainage or run-off, this being immediately available in the streams and rivers, and part is absorbed by the soil. From this last portion a large amount is taken up for the sustenance of plant life, some is held in the soil, while the remainder gradually percolates into the streams through underground channels and springs. It is estimated that from one-third to one-half of the total annual precipitation finds its way into the streams by run-off and the slower and steadier flow from underground storage. It is this total stream flow that supplies one of the two essential elements of hydraulic power.

More water is absorbed by a light, sandy soil than by heavy clay. Sand overlying clay or rock makes an excellent storage reservoir, and streams draining land of this character have a steady and reliable flow, which is lacking in streams that drain a hilly or mountainous country. The dense, rocky soil generally found in these latter regions absorbs very little water, especially where the slope is steep and where the forest is largely cut off, the greater part of the rainfall being carried into the streams by surface drainage before any absorption can take place. This results in a sudden increase in the stream flow after a storm, which lasts but a short time, then subsides as rapidly as it rose. Fortunately, many streams of this character have natural sites for storage reservoirs, and when these are developed, the run-off is conserved by holding back these floodwaters until they are needed.

In mountainous regions where the sources of the streams are in perpetual snow or glacial formations, the flow is equalized by the gradual melting of the snow and ice, so that it is very steady, though moderate in volume. This, with the high heads attainable in the abrupt falls and steep slopes of these regions, permits the development of a large amount of power from a small stream. The power that may be developed from a stream depends upon two essential factors — that

This is the first of a series of articles addressed to operators of relatively small hydro-electric plants dealing with the dam and its appurtenances, handling the river, hydraulic turbines and governors, generators, exciters and switchboards, and transmission and dispatching.

*Instruction Department, Consumers Power Company.

which we have been considering, the flow of the stream, or the amount of water it carries, and the head which is the difference in elevation between the upper and lower levels of the stream at the development. The force used to drive a water turbine comes from the hydrostatic or potential energy due to the weight of the column of water and to the hydraulic or kinetic energy due to this weight in motion.

Flow of Stream Depends on Rainfall

As has been seen, the first element depends upon the rainfall, the extent or area and nature of the watershed, the character of the soil and other factors which require a special study for each stream. The second element, the head, is dependent upon the contour of the land and, once developed, is constant or nearly so.

If the development is at high head, less water is necessary to produce a given power than at a low head. The vertical height of the water column determines the pressure on the turbine, and the available flow determines how large a turbine can be kept constantly filled with moving water. These factors determine the intensity and volume of thrust upon the turbine blades and therefore the number of energy units that can be generated.

Where power plants are operated in connection with an electrical transmission system, which permits the shifting of load from one plant to another, from one river to another or to steam plants, each plant and each stream may be operated at its maximum efficiency. This permits full use of the stream flow up to the plant capacity, and in case of a diminished flow, part-time operation at the most efficient gate opening. The water can be worked down the river without waste, the plant farthest upstream setting the pace for the others.

Estimating Flow From Past Records

It is desirable to know in advance as much as possible concerning the rainfall and run-off on the watershed, especially if conditions are such that all the power available can be marketed. Careful records will of course be kept at the plants, covering weather conditions, rainfall, and in some form, the volume of river flow. But these are records of past performance only and do not permit prediction as to the flow available the next day.

If there is a gaging station at a point twelve or twenty-four hours upstream, as the stream flows, and readings are taken at least daily and transmitted to the plant or dispatching office, ample warning of any change in conditions will be available, so that the plant or group of plants may be prepared to meet it by taking on more load or by backing down some of the load on the steam plants or to those on another stream. The gage should be set at a point where the river has a known and permanent cross-section, and the readings taken preferably by an old resident or riverman, who knows the stream and its peculiarities. A table or curve calculated from the average conditions as carefully observed at the gaging point would give the operator or dispatcher the approximate flow in second-feet to be expected at the power plant at a certain time and the flow available at a later hour for plants farther downstream.

Rain gages are a necessity in connection with any method of predicting stream flow. While a local rain that does not cover all parts of the ordinary inland watershed would not generally make a decided change in water conditions, there should be enough rain gages to furnish complete information as to the precipitation at all points on the watershed. In winter, temperature readings are also of value, as the temperature greatly affects the flow of most of the northern streams.

If there is an accurate map of the pond, showing the area at various elevations within the practical limits of operation, the operator or dispatcher can determine how much of the coming flow can be ponded or how much more or less than the expected amount of flow he can draw, and recover full head during the light-load period of the night. He will thus be able to dispense with guesswork, for he will have an inventory of his raw material on hand and in transit and will be able to schedule his output far enough ahead of production for efficient handling of the output.

Each river has its peculiarities, and until one has made a long and careful study of a given stream, he should not be too confident as to what it is capable of doing under different conditions. Reasoning that is correct for one stream does not always apply to another. Experience in connection with power-plant operation on fourteen rivers, large and small, convinced the writer that there is always something to learn when taking up work on a strange stream, and it is necessary to get acquainted with its seasonal moods and changes. Even those who know the river best will run into a new condition now and then, and it is an interesting study to work out the various problems that constantly arise.

The Plea of an Elevator

By William Zepernick

Forgotten I've been for many a day,
Tho' much is expected of me;
No time for cleaning and no time for play,
What is the answer to be?

Sometimes I'm tired and must take a rest,
Then comes a tirade of scorn.
"You're worse than the others; not one of the best."
This makes me sad and forlorn.

Why can't they treat me like some of my clan
That are cleaned and refreshened each week
By a regular attendant or maintenance man,
Or shall I become just a freak?

My contacts are burned and pitted and scored
Until I have acute indigestion;
My bearings are dry and I feel like a fraud,
And all of my actions they question.

My carriage is clean—this I'll admit—
But that is a similar story
To the boy who washed his face, and
It was his one crowning glory.

Like the boy in the story, my face is clean,
But that is as far as they go;
I am dirty and grimy where I am unseen;
Now what can I do, do you know?

My appeal is not mute; I growl now and then
From my gear, my rails or my brake;
But this is not cared for until the time when
I just have to shiver and shake.

Here is my plea. I trust you will heed.
Keep me clean and well oiled as I should be;
I know that I'll be a faithful old steed
And give you good service continuously.

Motor-Generators Rebuilt from Corliss-Engine Units

By W. NELSON SMITH
Consulting Electrical Engineer, Winnipeg Electric Railway Company

The author tells of an unusual engineering task, whereby long-continued operation under adverse conditions was avoided, and additional generating equipment promptly provided, in spite of the impossibility of obtaining reasonable terms, both as to price and delivery, from the manufacturers, owing to war conditions. Three old direct-current generators and two alternators, all direct-connected to Corliss engines and already in the shadow of the scrap heap, were dismantled and reassembled into two motor-generator sets, using the Corliss-engine bearings and shafts, with suitable bushings to complete the armature fits. In this way new equipment of about 1,600 kw. capacity was obtained with a saving of about $40,000 on the manufacturers' bid, and endless delay was avoided.

IN THE course of changing the trolley distribution of the Winnipeg Electric Railway from two-wire to three-wire operation[1] for the purpose of electrolysis mitigation, additional motor-generator equipment became necessary, but the prospects for securing this from manufacturers during 1918 and 1919 were so impossible as to price and time of delivery that the writer was prompted to study carefully the possibilities of converting some old station equipment to this new use, in order to accomplish the proposed changes within the required time and with the least expenditure of additional capital.

The steam plant that had constituted the original source of the company power supply, located on Assiniboine Avenue, was permanently closed down in the spring of 1918. It dated back to 1898 or earlier and was fitted entirely with engine-type generating units, both alternating and direct current. The alternating-current units had been superseded since 1911 by a modern turbine power station which relays the hydro-electric system that has supplied nearly all the company's power since 1906. The old direct-current steam units had since been used only on rare occasions, such as heavy blizzards.

The engine-type direct-current generators comprised one 850- and two 400-kw. machines, the latter shown in Fig. 1 in their original condition in the old generating station. The former ran at 85 r.p.m. and the two smaller machines at 100 r.p.m. Among the engine-type alternators there were two 800-kw. machines operating at 90 r.p.m. The fact that the speeds of the direct-current units were so near those of the alternating-current units immediately suggested the possibility of yoking them up together, with one 800-kw. alternator driving the 850-kw. railway generator, and the other 800-kw. alternator driving the two 400-kw. generators as a three-unit machine. There was no doubt that an 85-r.p.m. railway machine would generate 575 to 600 volts when run at 90 r.p.m., and a test performed for the purpose showed that each of the 400-kw. railway machines could generate 575 volts at 90 r.p.m. With these facts established, it appeared feasible to create an addition to the motor-generator equipment of the company to the extent of at least 1,600 nominal kilowatts out of equipment on hand. The engineering problem was thus reduced to the mechanical design and assembly of these machines as motor-generators, on suitable shafts and bearings. The new substation at St. Boniface was then being constructed, and provision was being made for space for a railway motor-generator to take care of the trolley lines east of the Red River. It was thought worth while to reconstruct a three-unit machine for the substation out of the two 400-kw. generators and one 800-kw. alternator.

The old engines on which the two 400-kw. machines were mounted were of the cross-compound Corliss type. One of them was of so old a pattern that the engine frames and the pillow blocks were in separate pieces bolted together, and this suggested utilizing the two engine pillow blocks as the center bearings of the three-unit machine, between which the alternator would be mounted as a motor. A pattern of a ring-oiling bearing was found in a local foundry which proved to be easily adaptable for the two outboard bearings required. The shaft from the oldest Corliss engine was found to be just long enough to provide shafts for mounting the direct-current generator armatures, after being cut in half. It remained to find a suitable central shaft on which to mount the rotor of the alternator which was now to be turned into a motor. An old engine shaft was discovered at another machine shop, which was just large enough so far as its strength was concerned, though not sufficiently large in diameter to fit the hub of the alternator rotor which had been fitted to a 22-in. engine shaft. This fit was accomplished by providing a heavy cast-iron bushing, and the remaining necessary elements were two cast-steel face couplings and the necessary keys, with some smaller cast-steel bushings for filling out certain places on the generator shafts that were too small for the direct-current armature fits. Fig. 3 shows how these elements are all assembled to create the newly reconstructed three-unit machine, and Fig. 2 shows the finished machine operating in the substation.

The order of operation was as follows: The flywheel of the oldest Corliss engine connected to a 400-kw. direct-current generator was taken off the shaft, the crank discs pulled off and the old engine frames separated from the pillow blocks. The armature of the generator was then pressed off the shaft, and the latter was sent to the machine shop to be cut in two, turned up for coupling seats and journals, and fitted with the necessary bushings and keys for completing the altered

[1] An article describing this change and the reasons for it was published by the author in the *Electric Railway Journal*, March 26, 1921.

armature fits. The other Corliss engine was of more modern design, and it was thought best to save it for the time being, for a possible sale, so that all that was done to it was to dismantle the shaft, pull off one crank disc and remove the armature.

When the two new armature shafts were ready, they were brought back to the power plant, each with its half-coupling and the necessary keys, and the two direct-current armatures were then pressed on. Meantime the central piece of shafting was also fitted with the heavy bushing of 22 in. external diameter for the hub of the rotor of one of the 800-kw. alternators, the cast-steel bushings for forming new journal bearings upon it, and the other halves of the couplings. The new outboard bearings were then completed and all the parts, bearings, shafts, armatures and fields taken to the substation and assembled. All the machine-shop operations consumed about 2½ months, and the field work of mechanical and electrical assembly at the substation took about two months. The mounting of the alternator rotor upon the motor shaft was quite simple, because the rotor is built in halves bolted together and therefore did not require a press fit.

No bedplate was thought necessary for holding this machine in alignment. The stationary parts are very heavy and are bolted down to separate foundation piers which are joined together at the bottom by masses of concrete and the top by the reinforced-concrete floor. The machine foundation piers all rest on a single con-

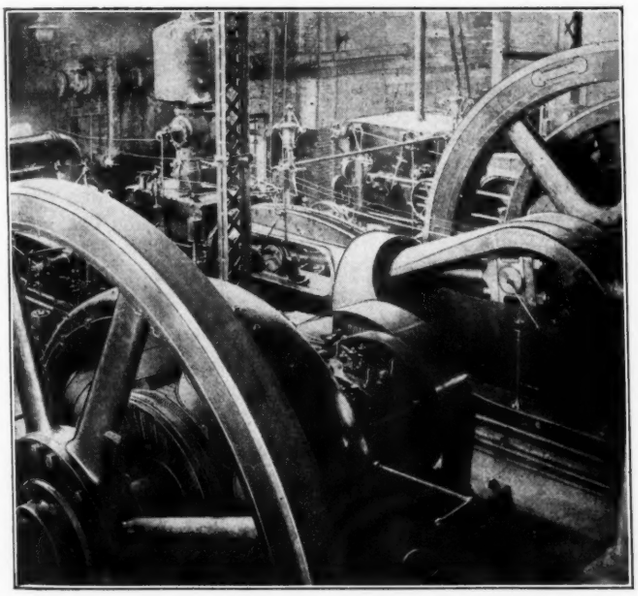


FIG. 1. RAW MATERIAL FOR REBUILT MOTOR-GENERATOR SETS

Corliss engine-driven units in the old generating station, one of two 400-kw. direct-current units in the foreground, and one 850-kw. direct-current unit in the background.

crete slab about 32 ft. long, 22 ft. wide and 1 ft. thick, reinforced with old 60-lb. rails.

The exciter for the field of the alternator is a 30-kw. slow-speed machine, which had formerly been belted through a pulley on the engine shaft. In the new substation this exciter is driven through an inclosed silent chain by a 40-hp. induction motor.

The old pillow blocks are fitted with the four-part babbitted bearings and adjusting wedges with which they were originally provided, so that close adjustment is possible. The two new outboard ring-oiling bearings are adjustable vertically by means of shims and horizontally by means of adjusting bolts.

The work of preparing shop drawings for the reconstructed unit began about Nov. 1, 1918. The shafts were put in the shop about Jan. 1, 1919, and the shop work of preparing the shafting and making the couplings, bushings and keys, and pressing on the armatures took until

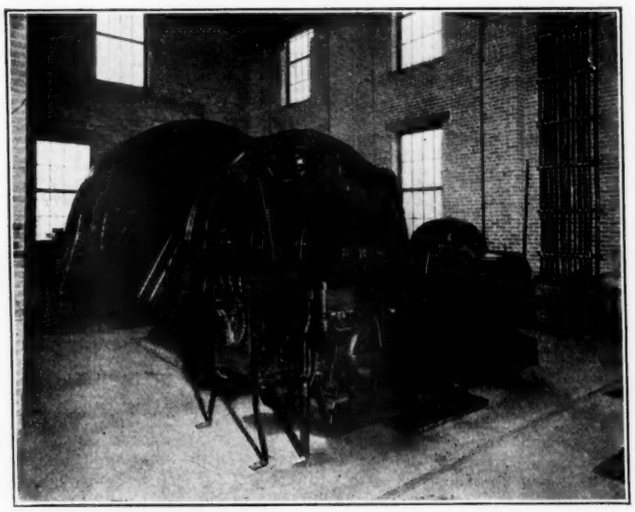


FIG. 2. THREE-UNIT MOTOR-GENERATOR SET REBUILT FROM OLD GENERATORS

One 800-kw. alternator in the center operating as a synchronous motor driving two 400-kw. direct-current generators for three-wire service.

April. The work of assembly in the substation began early in April, but was interrupted by the general strike in May and June. Work was resumed at the end of June, and the machine was ready to turn over the first week in August. After the usual trying-out period of eliminating minor troubles, mostly with the center bearings, the machine went into permanent operation about Sept. 1, 1919, and has since given very satisfactory service excepting for a period of several weeks during the summer of 1920, when one of the main pillow-block bearings burned out, owing to a failure of the lubrication. Since that time, however, its service has been continuous and very satisfactory. It is a fact that the two generators when running in parallel operate together much better now than they ever did when they were mounted on separate steam engines in the old steam plant. Occasionally, they run two-wire, but the usual operation is three-wire with the generators in series.

The motor-generator set, having a speed of only 90 r.p.m., runs very silently, and there is no perceptible vibration. A person standing close to it with his back turned would never know it was running.

The only element of mechanical weakness is the fact that the lubrication of the two center bearings is not strictly automatic, requiring more attention on the part of the operator than is usual for substation machinery. With the addition of an oil pump to the outfit this season, this defect will become unimportant. Electrically, however, the machine seems to be 100 per cent perfect in its performance, although the two generators are respectively about 19 and 23 years old.

The success of this reconstructed motor-generator set was sufficiently marked to justify the conversion of the two remaining engine-type machines into a two-unit

motor-generator. It was therefore decided to scrap the 1,200-hp. Corliss engine which had been driving the 850-kw. direct-current generator, excepting its armature shaft and main bearings. Careful measurement had indicated that if the flywheel, eccentrics and crank discs were removed from the engine shaft, there would be just room enough in the space formerly occupied by the flywheel to mount the rotor of the second 800-kw. alternator and at the same time provide sufficient space in the pit for shifting the alternator stator to uncover either field or armature for inspection or repairs. Fortunately, this could be done without moving the heavy direct-current armature from its position on the shaft, for it is about 10 ft. in diameter, weighs something like 36 tons and had required a force estimated at 400 tons to press it on the shaft. The shaft and bearings being therefore on hand and all made to size, the mechanical operations were simple and consisted in cutting away all unnecessary metal from the heavy cast-iron engine-frame housings in which the main pillow-block bearings were set; taking off the 50-ton flywheel with the eccentrics and crank discs; cutting a new keyway for the hub of the alternator rotor; providing a cast-iron bushing of about 22 in. inside and 24 in. outside diameter and long enough to carry the rotor hub and the collector rings, and a suitable bushing to fit on the external shoulder formerly occupied by one of the crank discs, where it was decided to mount the 60-in. pulley for the belt drive to the exciter. The remainder of the engine was sold for junk.

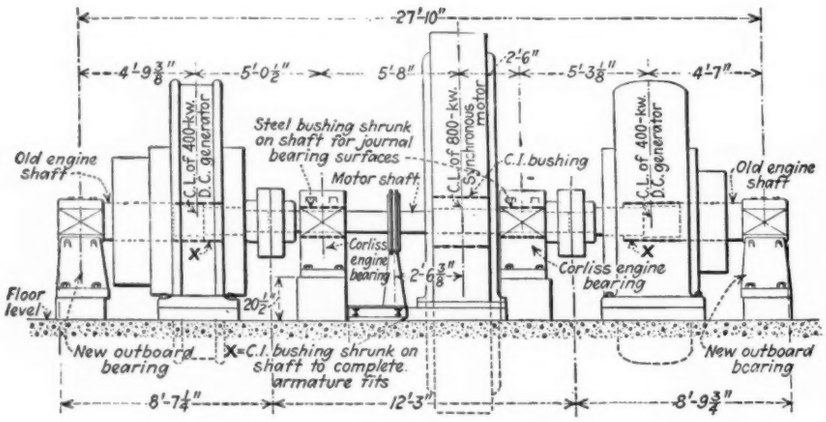


FIG. 3. ASSEMBLY OF THREE-UNIT MOTOR-GENERATOR SET SHOWN IN FIG. 2

The bearings of the old Corliss engine were used for center bearings, and two new bearings ordered for outboard bearings. The old Corliss engine shaft cut in two served for the two direct-current machines. A second-hand shaft was found for the alternator. Cast-iron bushings of suitable diameter were shrunk on these shafts to fit the bore of the three machines, and steel bushings were used to enlarge the shaft and provide new journal surfaces in the center bearings. Note the concrete pedestals or pads necessary to bring the bearings and machines in correct alignment.

Fig. 5 shows the layout of this assembly excepting the exciter drive, and Fig. 4 shows the complete unit including the exciter. No electrical changes were made on the generator. This machine, as well as the three-unit set, is started from the direct-current end. Work on it was started Feb. 1, 1920, and the rebuilt machine was ready to turn over early in July. It went into regular operation in October, 1920.

As in the case of the first reconstructed machine, the only trouble that developed was in the bearings, one of which had a crack in the babbitt of the lower portion, inherited from its steam-driven service, and after several ineffectual attempts to remedy this, the bearing was rebabbitted. There was some further trouble from throwing oil, as the shaft was of sufficiently large diameter to make its peripheral velocity greater than in the case of the first machine, where this trouble had not developed. This was finally overcome by the addition of discs inclosed in sheet-metal guards.

Electrically, both these reconstructed motor-generator sets operate perfectly. Mechanically, there are only two or three elements that would be changed if the work had to be done over again. In the case of the three-unit machine it would have been better to have provided cast-iron sole plates about 15 in. deep underneath the two center bearings so designed that they could be readily withdrawn from underneath the pillow blocks, in order to permit the lowering of the pillow blocks when any repairs were required on the center bearings, as this would save the trouble of uncoupling the motor shaft and lifting it out of the center bearings at such a time. It would also have been better to have designed a modern lubricating system for the old engine bearings on both machines, prior to the construction, including the oil-throwing discs required for the 22 in. shaft.

The original cost of the five old generators purchased between 1898 and 1905, was about $93,000. An engineering appraisal of the property made in 1915 had set the present value of these machines at about $41,000, but at the time the steam plant was ordered discontinued, these generators were regarded as obsolete. The cost of reconstructing them and setting them in operation, as described, exclusive of foundations, was about $31,000 for labor and material on a war-time basis. In pre-war days the same work would probably not have cost over $18,000.

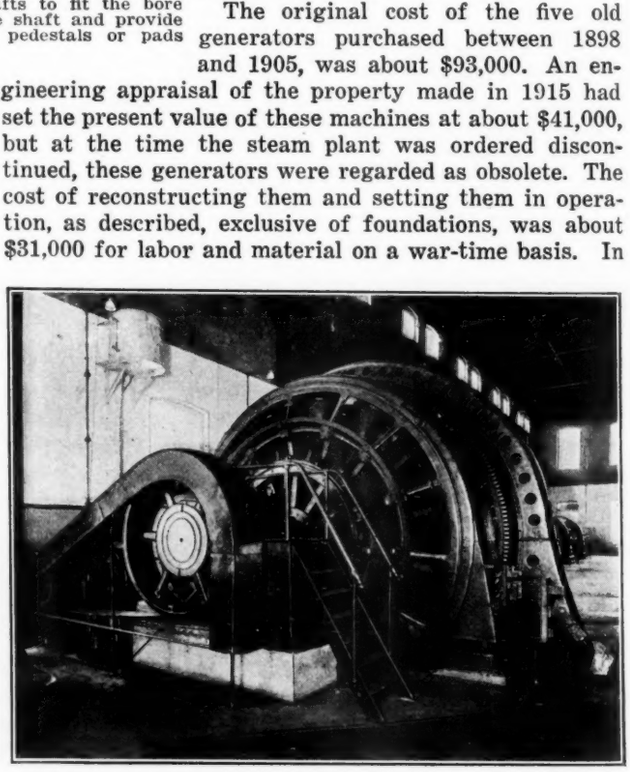


FIG. 4. REBUILT TWO-UNIT 800-KW. MOTOR-GENERATOR SET

Built up from the 850-kw. direct-current generator visible in background of Fig. 1, and from one 800-kw. engine-type alternator serving as a synchronous motor.

Quotations on new motor-generator equipments in 1918 were on the basis of more than $40 per kilowatt at the factory, or say $45 per kilowatt erected in Winnipeg, which would have amounted to about $72,000 of new

capital for 1,600 nominal kilowatts. The construction herein described is therefore believed to have saved the railway company over $40,000 and prevented what would otherwise have been a deliberate waste of valuable equipment, for these machines have proved their title

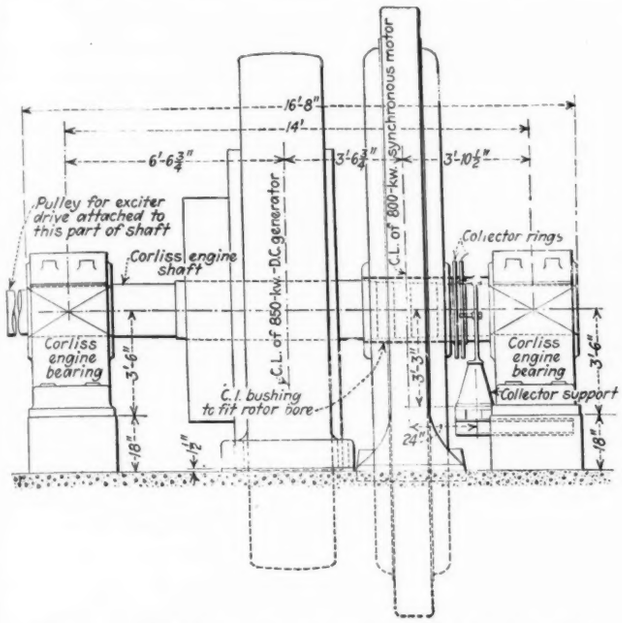


FIG. 5. ASSEMBLY OF TWO-UNIT 800-KW. MOTOR-GENERATOR SET SHOWN IN FIG. 4

The 850-kw. direct-current generator, its shaft and bearings were left untouched. The flywheel and other parts of the Corliss engine were removed from the shaft and replaced by the rotor of one of the 800-kw. alternators, with a suitable cast-iron bushing to fit the rotor bore. Note the concrete pedestals or pads necessary to bring the direct-current machine and the bearings in the correct alignment, while the altenator feet were dropped slightly below the floor level for this purpose.

to a new lease of life and are able to render the same service now that they did twenty years ago.

It is quite possible that other utility companies may have some similar equipment standing idle which could be turned to good account in old power plants or wherever there is sufficient room. One does not ordinarily estimate on motor-generators of a speed as low as 90 r.p.m., but for the sake of encouraging conservation, the foregoing machines can be pointed to as examples of what can be done, even when there are no precedents to follow. During the construction period they were frequently dubbed "war-babies"—which in fact they were, but less expensive and more profitable than some other creations of the same period.

The Vulcan Iron Works, of Winnipeg, performed all the heavy machine-shop work and furnished all new material for both machines excepting the outboard bearings of the three-unit machine, which were supplied by the Manitoba Bridge and Iron Works, of Winnipeg. The steel castings for bushings and couplings were made at a neighboring steel foundry. Bolland Bros., moving contractors, of Winnipeg, did all the moving of heavy parts, incluing the dismantling of the 850-kw. direct-current engine unit. The dismantling of the 400-kw. direct-current engine unit and the 800-kw. alternator units was accomplished by the railway company's construction force.

The execution of mechanical details and all the electric work on both units were executed under the immediate superintendence of Arthur Trott, electrical superintendent, assisted by K. C. Ferguson. The difficult task of assembling and lining up the three-unit machine was in charge of Thomas Losh, a warrant machinist from the British Navy. The drawings were made by W. C. Taylor and Alan Couch, of the railway company's staff.

The general responsibility for the conception, design and results rested with the writer.

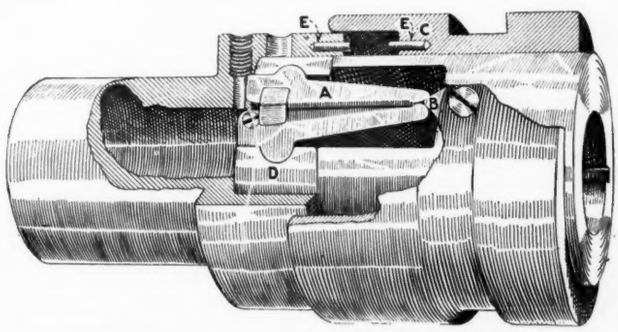
Johnson Positive Locking Friction Clutch

A friction clutch that permits of starting its load under friction only and becomes locked against slippage when the clutch is completely engaged, is a design that is somewhat out of the ordinary. However, that is what the Johnson friction clutch does.

A semi-sectional view of the clutch is shown by the illustration. It consists of a body that is fastened to the shaft and carries a split ring in which are inserted a pair of toggle levers *A*. A curved wedge *B*, which is made a part of a sliding shipper sleeve *C* forces the lever apart, which expands the ring *D*, bringing its outer surface into frictional contact with the inner surface of the friction cap.

In addition to the friction feature of the clutch a positive locking arrangement has been incorporated. This consists of six pairs of opposing pins spaced equally distant around and on the edge of the friction cap and on the shoulder of the outside shifter sleeve *C*. These pins *E* are shown in the disengaged position, as are also the friction surfaces.

As the sleeve travels to the left, the friction surfaces begin to take their load and practically pick it up to



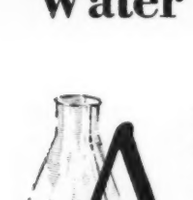
SEMI-SECTIONAL VIEW OF CLUTCH WITH LOCKING PINS

full speed before the opposing pins come into contact. With the full throw of the clutch the pins become engaged as a locked drive and slippage under load is impossible. This clutch is manufactured by the Carlyle Johnson Machine Co., Manchester, Conn.

The number of employees in representative water, light and power plants in New York State had increased, in April, 1921, to 111 per cent of the number in June, 1914, whereas in the same time the total wages paid such employees increased to 241 per cent. It is interesting to compare these figures with the averages of the corresponding figures for other New York industries, which are, respectively, 94 and 195. These facts are from a bulletin of the New York State Industrial Commission.

Water Softening by the Cold Lime-Soda Process

By GEORGE C. COOK



ALTHOUGH the lime-soda process is probably the most extensively used system of water softening for feed-water purposes, it is nevertheless a fact that many plants are not giving the best possible results because of lack of a full understanding of the principles involved on the part of those entrusted with their operation.

The most commonly found impurities in water which may cause scale or corrosion in boilers are the sulphate and bicarbonate of calcium and the carbonate and chloride of magnesium. These substances may be almost completely removed as insoluble precipitates by the addition of the proper proportions of sodium hydroxide and sodium carbonate. In the lime-soda process, calcium hydroxide (hydrated lime) and sodium carbonate (soda ash) are added to the water, the calcium hydroxide reacting first with a portion of the sodium carbonate to form sodium hydroxide and a precipitate of calcium carbonate. While the desired reagents are sodium carbonate and sodium hydroxide, it is preferable to produce the latter in the presence of the water to be treated by the reaction between calcium hydroxide and sodium carbonate because the substances mentioned are cheaper and the heavy precipitate of calcium carbonate formed acts as a coagulant in settling.

How boiler priming and scale formation may be prevented by simple chemical treatment. How to conduct tests for causticity and alkalinity in feed water is told in detail.

Softeners working on this principle may be divided into two general classes, the continuous and the intermittent; in the former the water to be purified flows to the softener in a continuous stream, while in the latter it is treated in batches. In either case successful treatment requires a proper proportioning of water to chemicals, thorough mixing and agitation of both, sufficient time for the completion of the chemical reaction, and complete clarification by sedimentation and filtration. The essential parts of a continuous softener are the mixing vat for mixing and dissolving the chemical charge, the proportioning device for maintaining the correct ratio of chemicals to water, the mixing chamber for mixing and agitating the water and chemicals, the settling chamber and the filter. The essentials of the intermittent plant are the mixing vat for chemicals, two or more reaction tanks equipped with stirring devices and a filter.

In operating such a plant it must be borne in mind that the treatment must be so controlled as to insure the fulfillment of two conditions: First, that the proper amount of chemicals should be supplied and sufficient time allowed to give the desired treatment; and second, that all suspended matter should be removed from the treated water. In order to regulate the amount of chemicals, it is only necessary to make three simple chemical tests of the treated water and to intelligently interpret and act on the results obtained. These tests are: First, for causticity; second, for alkalinity; third, for hardness. In order to make these tests the following solutions and apparatus are required: 1 burette, 50 c.c.; 1 burette stand; 1 porcelain dish; 1 bottle (8-oz.) with stopper; 1/50 normal hydrochloric- or sulphuric-acid solution; phenolphthalein solution (2 grains per liter 95 per cent alcohol); methyl orange solution (1 grain per liter of water); standard soap solution.

Directions for Making the Tests

Causticity: To 100 c.c. (of the sample of water to be tested) in a white porcelain dish add 5 drops of phenolphthalein solution. This will color the water a pronounced red. Run in N/50 acid slowly from the burette (stirring at the same time) until the red color becomes fainter, then drop by drop until the red color has just disappeared. Take twice the number of c.c. of acid used to represent the causticity in parts per 100,000.

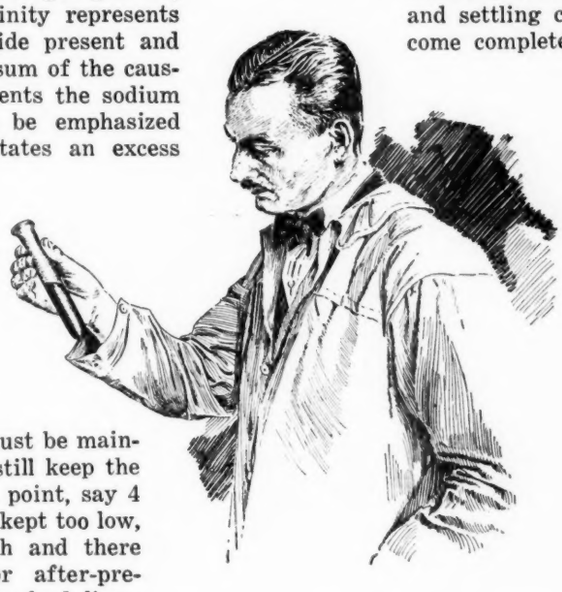
Alkalinity: Using the same sample of water upon which the causticity has just been determined, add two drops of methyl orange, which will produce a yellow color. Run in N/50 acid slowly from the burette while stirring until the yellow color changes to a faint red. The number of c.c. of acid used to change the yellow color of the methyl orange to red plus the number of c.c. of acid used in the causticity test to destroy the red color of the phenolphthalein is the alkalinity in parts per 100,000. It is difficult to tell just when the proper shade of red has been obtained when using methyl orange as an indicator, and to aid in doing this a distilled-water blank for comparison is useful. Measure 100 c.c. of distilled water into another porcelain dish and add two drops of methyl orange, then add $\frac{1}{10}$ c.c. of N/50 acid, which will give the desired faint-red color. When testing the treated water, add acid until the same shade of red is obtained. For accurate results the $\frac{1}{10}$ c.c. of acid for the blank test should be taken from that used on the test sample.

Hardness: A 100-c.c. sample is placed in an 8-oz. bottle and soap solution is run in from the burette, $\frac{1}{2}$ c.c. at a time, shaking the bottle vigorously after each addition, until a permanent lather is obtained (one which will persist for five minutes). Soap solution as purchased from the laboratory, is furnished with a constant, that is, that 1 c.c. is equivalent to a certain amount of hardness. This is correct at one point, but if used with waters having a wide range of hardness, it will introduce a considerable error. A much more satisfactory method is to plot a standardization curve for the soap solution and use this to translate the results of the soap test into terms of hardness. To obtain this curve, a solution of calcium chloride should be obtained such that 1 c.c. equals one part in 100,000 calcium-carbonate hardness. Hardness tests with the soap solution can now be made upon mixtures of 1 c.c. calcium-chloride solution and 99 c.c. distilled water (representing hardness of 1 part per 100,000), 2 c.c. and 98 c.c. distilled water and so on, over as wide a range as desired. The curve will then be plotted

with c.c. of soap solution as one co-ordinate and hardness in parts per 100,000 as the other.

The water after treatment may contain any of a number of compounds of which the following are typical: Calcium bicarbonate, calcium sulphate, calcium hydroxide, calcium carbonate, sodium carbonate, sodium bicarbonate, sodium hydrate.

If the water is properly treated, there will not be any calcium bicarbonate, calcium sulphate or calcium hydroxide present, but there will be some sodium carbonate, sodium hydroxide and calcium carbonate. By this system of treatment it is not possible to eliminate the calcium carbonate entirely, but by increasing the sodium-carbonate and sodium-hydroxide content of the treated water, the calcium-carbonate content is reduced. There will be an excess of sodium hydroxide and sodium carbonate present in the treated water if from the tests the causticity is greater than the alkalinity, and twice the alkalinity is greater than the sum of the causticity plus the hardness. When the foregoing is so, the causticity minus the alkalinity represents the amount of sodium hydroxide present and twice the alkalinity minus the sum of the causticity plus the hardness represents the sodium carbonate present. It should be emphasized that proper treatment necessitates an excess of sodium carbonate and hydroxide in the treated water at all times, but the degree of excess that is carried depends on the local conditions; that is, the character of the raw water and the conditions under which the treated water is used. If the treated water forms the entire boiler feed, the excess must be maintained as low as possible and still keep the hardness down to the required point, say 4 or 5 parts per 100,000. If it is kept too low, the hardness will be too high and there will also be a tendency for after-precipitation to take place in the feed lines.



The danger of carrying the excess of sodium carbonate and sodium hydroxide too high lies in the increased tendency to priming due to the concentration of these salts in the boilers. If the softener merely supplies makeup (the greater part of the feed consisting of condensate from surface condensers), the excesses of sodium carbonate and hydroxide may be carried much higher without causing danger from priming in the boiler. Where the makeup is a low percentage, the sodium carbonate may be carried as high as 9 or 10 parts per 100,000 and the sodium hydroxide 4 or 5 parts per 100,000 without causing trouble. It should always be borne in mind that the ultimate object to be obtained is the elimination of scale formation in the boilers. It is quite possible where there is a complicated piping system that there should be a leakage of raw water into the treated-water system between the softening plant and the boilers; this should be carefully guarded against. Where surface condensers are used, there will almost always be some leakage of raw water into the condensate and every endeavor should be made to maintain it at the minimum. Regular tests similar to those of the treated water should be made of the feed water entering the boilers, and there should always be some excess of sodium carbonate and hydroxide at this point. The reaction that takes place between the raw water entering in the condensate and the excess of reagents in the treated water will cause a precipitation in the feed-water heater and feed lines, but this is preferable to the formation of a hard scale in the boilers, as would otherwise occur.

Where the source of the raw water is a river or shallow wells, it sometimes happens that the character and quantity of scale-forming impurities is subject to changes requiring a corresponding change in treatment. Tests of the alkalinity and hardness of the raw water will indicate changes in its composition and so suggest the change required in its treatment. This is of particular advantage with the continuous type of softener where otherwise no change in treatment would be indicated until the water had passed through the softener.

In addition to using the proper proportions of chemicals, it is necessary to see that the other requirements are fulfilled; namely, thorough mixture of chemicals with the water, sufficient time in the reacting and settling chamber for the reaction to become complete and the major portion of the precipitate to settle, and complete removal of any remaining suspended matter on passing through the filter. Mixing is made complete in the intermittent system by mechanical agitators in the reacting tanks; in the continuous system it is effected by the eddies set up by the water in passing through the machine. This is more or less thorough, depending on the design of the machine. The time required for the completion of the chemical reaction is from four to five hours, and it is upon this time that the capacity of the machine is rated. If the plant is run at higher than its rated capacity, insufficient time will be allowed for the reaction and there will be after-precipitation, causing sludge to be deposited in the piping beyond the filter and eventually clogging up the lines. The same effect will be produced if sludge is allowed to collect to an unusual degree in the reacting tank of a continuous softener, since it results in cutting down the volume and causing the water to pass through the machine in a shorter time.

Both pressure- and gravity-type filters have been used with quartz as a filtering medium, and some continuous softeners are equipped with excelsior filters. Excelsior filters are not considered so efficient or satisfactory as the quartz filter and require very careful preparation of the filter bed to prevent short-circuiting. Furthermore, the filtering material must be renewed at frequent intervals. Any filter, to perform satisfactorily, must be washed at regular intervals; otherwise a dirty filter will result and deposits will be carried over into the pipe lines, resulting eventually in their stoppage. Quartz filters are equipped with a piping system for washing, which is embedded in the filtering medium and is assisted by a system of air jets. The efficiency of a sand filter depends on the careful design of the washing system. Excelsior filters are washed by draw-

ing the water down in the reacting tank and washing the upper surface of the filter with a strong stream of water from a hose. The carbonates that are precipitated in the reacting tank settle to the bottom, forming a heavy sludge. This must be removed at regular intervals in order that the capacity of the tank shall not be diminished. The removal is accomplished by means of blowdown piping having openings uniformly distributed over the bottom of the tank, through which the sludge is washed out. There is a tendency for the sludge to pack and bridge over the openings, and to prevent this it has been found advisable to provide a blow-back connection by means of which water under pressure may be forced in a reverse direction through the blow-down piping, thus keeping the holes open and loosening up the sludge.

Strange to say, many operators do not seem to appreciate that the mechanical features of a softening plant require the same attention as similar mechanism would in other places. Journals must be lubricated, parts maintained in alignment and worn parts replaced. Care should be taken also to keep the plant in a state of cleanliness and not allow chemicals to spatter and cake up in places that are not intended for them.

Suggestions for Operation

The following suggestions are given for the operation of a continuous softener: Care should be exercised in weighing out the correct amount of lime and soda and in using the exact amount of water for each charge, as a few pounds of chemicals spilled or a few inches of water more or less in the chemical tank may introduce a serious error in the treatment. The sludge should be removed twice daily by blowing down until the discharge runs clear. If a blow-back connection is provided, this should be used each time before blowing down. Journals should be oiled twice a day. The filter should be washed every two weeks and the condition of the filtering material should be inspected at intervals so that it may be renewed when necessary. Analyses of the raw water for alkalinity and hardness should be made once a day, or oftener if the water is found to be subject to rapid changes, and the treatment changed to correspond to any severe changes. Analyses for causticity, alkalinity and hardness should be made twice a day of the treated water and of the feed water entering the boiler, and the treatment should be made such that there will be at all times a slight amount of sodium carbonate and sodium hydroxide in the boiler feed, thus insuring the minimum amount of scale-forming material entering the boilers. Inspections of the treated-water samples should be made for turbidity as a check on the action of the filter.

The Use of Carbonized Fuels for Generating Steam*

By F. P. Coffin†

Coke breeze and the smaller sizes of gas coke are burned in gas works for generating steam. Usually they are fired by hand and burned on pinhole grates; however one type of traveling-grate stoker can be used for burning breeze. A strong draft is necessary when burning these fuels.

Semi-coke can probably be burned similarly to coke breeze and gas coke, but it has some important advantages. In small boiler plants such as those used for heating buildings, it should make a good smokeless fuel. When automatic firing is desired, a method has been used that consists in firing granulated fuel pneumatically over a grate.

Coke has been burned under boilers in Germany, more extensively than in America, and their experiences during the war are of interest.[1] It was found that gas coke is easier to ignite than metallurgical coke because its structure is less compact. Coke is more difficult to bring to a state of incandescence than coal, but it burns more slowly and keeps the shape of the lump longer. Because it gives off its heat more slowly and is a more bulky fuel, it is necessary to use a larger grate and a deeper fuel bed.

It has been stated on many occasions that with coke a boiler cannot deliver as much steam as with coal, especially when working at overload. This is due to the unsatisfactory flame formation resulting from the lack of volatile matter. Also, the superheater temperatures are lower, owing to the shorter flame and to a greater amount of excess air. When burning coke on chain-grate stokers, therefore, it was found desirable to gasify a part of the coke in the hopper by making this a gas producer. The hopper was fitted with an inclined grate, and a vigorous fire was maintained there. Supplementary air was admitted to the combustion chamber, through pipes that pierced the fire arch, and this allowed the producer gas to burn above the fuel bed. The fire in the hopper also served to ignite the incoming coke.

The limitations of coke as a boiler fuel are clear. Some of these limitations are to be found also in semi-coke, such as greater bulk than coal and lack of caking properties in the finely divided portion of the fuel. The small particles, in some instances, have been so light that they were blown away by a strong draft.

Semi-coke, however, may be made with a considerable amount of residual volatile matter, and this provides a good flame formation. It may be made fairly dense by being subjected to pressure, while in the plastic stage, during distillation in some processes.

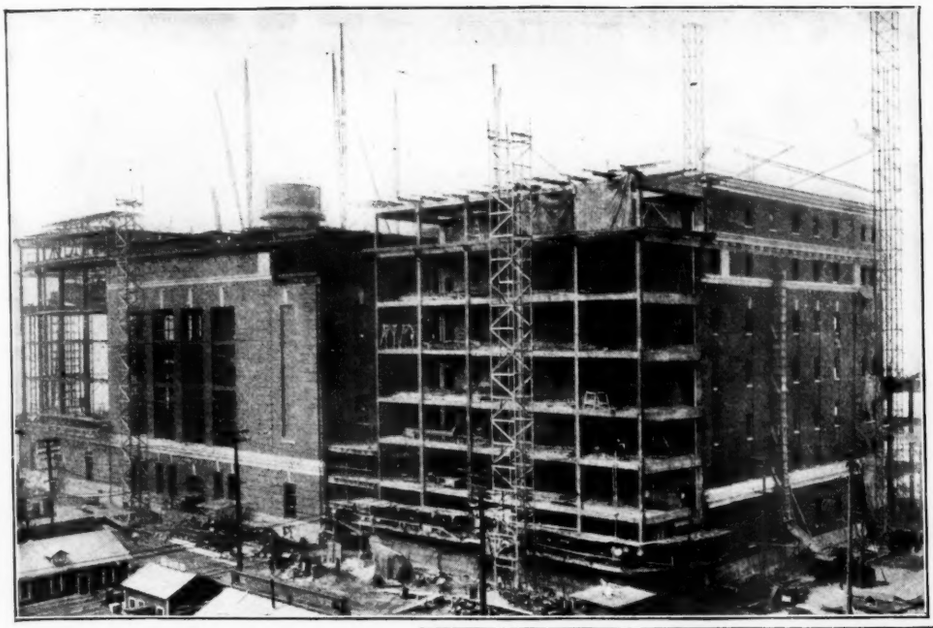
While, therefore, it should make an excellent steam fuel for small boiler plants in lump form, it will probably be found advantageous to subject it to further preparation by granulating or pulverizing, before using it in larger plants. The pulverizing of semi-coke will have several important advantages, as compared with burning it in crude form:

1. The disadvantages which are incident to the bulkiness of the crude material will be circumvented.
2. It can be more readily conveyed, handled and burned.
3. It can be more efficiently utilized for carrying intermittent loads, such as the peak loads in power systems where the base load is carried by burning byproduct producer gas, which may be made from semi-coke prepared in the same distillation plant.
4. Pulverized semi-coke may be readily stored and kept available for emergency use without danger from spontaneous ignition. This is an important consideration in reserve steam-power stations used in connection with hydro-electric plants.

*From the author's contribution, "The Utilization of Coal on a Multiple Products Basis," to R. F. Bacon's and W. H. Hamon's forthcoming book "American Fuels."

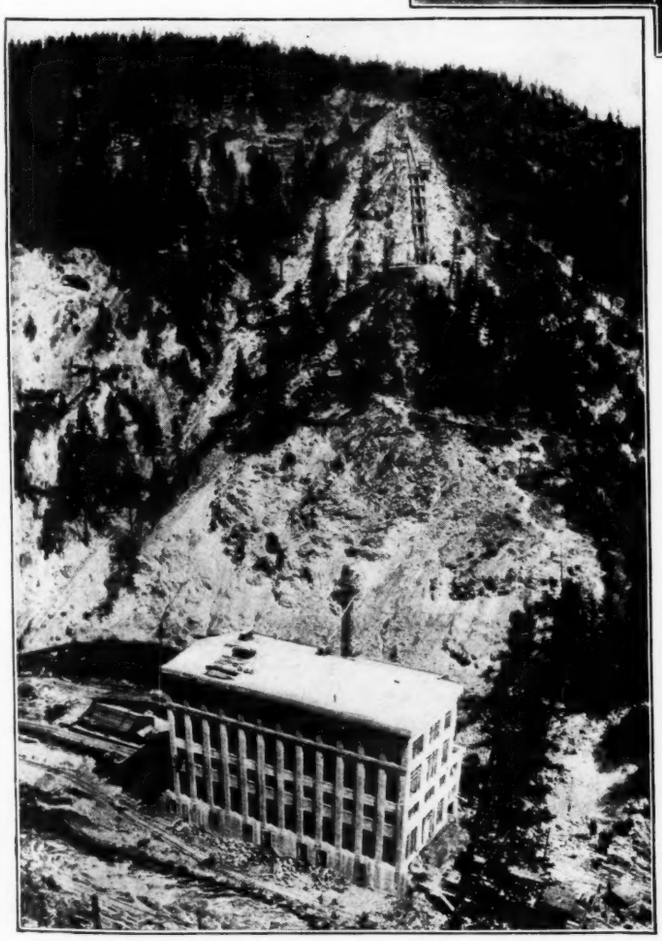
†Research Laboratory, General Electric Company.

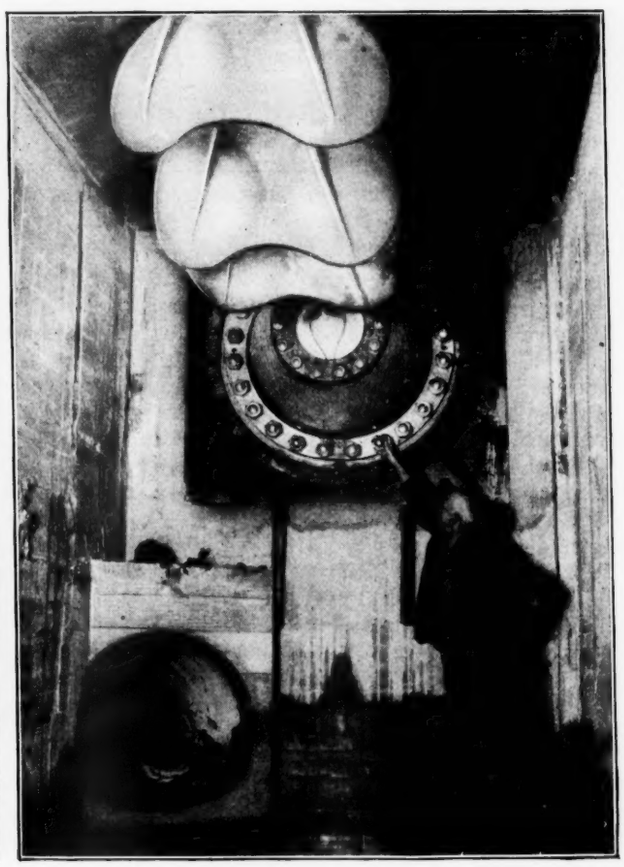
[1] "Coke Firing," by Reichelt, reprinted in *Mechanical Engineering*, August, 1919, p. 696.



At the left is shown the new Hell Gate Station of the United Electric Light and Power Co., of New York, as it appeared June 27. The good progress made is shown by the view below, which was taken Nov. 5, 1920. The new plant, which is being built by Thomas E. Murray, Inc., will be fully described in a later issue of *Power*. The station will have an ultimate capacity of 280,000-kw., half of which will form the initial installation, consisting of four 35,000-kw. turbo-generators, each served by a battery of three double-ended boilers. Unlike the usual layout, the turbine room is next to the river, with the boiler room between it and the switchhouse. Another special feature is that each of the circulating pumps has its own tunnel.

Below, a birdseye view of the new Caribou Plant of the Great Western Power Co., showing the penstocks in the background. At the right of it is an interesting photograph taken in the wheel pit of one of the plant's two 30,000-hp. impulse turbines. The great size of the buckets is well shown here. The wheel weighs 25 tons and revolves at 171 r.p.m. under a 1,008-ft. head. Stone & Webster were the engineers in charge of the construction of the plant.





Semi-Diesel Engines in Small Central Stations

By W. S. BARNES

BEFORE the development of the internal-combustion engine it was almost out of the question for a small town to maintain an electric-light plant on a paying basis, on account of the limited revenue and the excessive fuel and other operating costs encountered with the customary small steam installation.

The internal-combustion engine has long since reached a point where this form of power is as dependable as any other for this service. Because of the high fuel economy and reasonable labor costs it is possible for small communities to have just as good service as the larger cities at reasonable rates, and with proper management the plant will pay satisfactory returns on the investment. One of the early installations of this kind was at Bonner Springs, Kan. This plant was installed in 1904 and was originally equipped with a 20-hp. and a 30-hp. gasoline engine belted to direct-current generators. In 1911 this plant was sold and the new owners immediately began to improve it. The system was changed to alternating current, and the old machinery was replaced by a new unit consisting of an 80-hp. natural-gas engine, direct-connected to a 60-kva., 2,300-volt three-phase 60-cycle alternator. About a year later 24-hour service was established and this unit operated continuously with only occasional shutdowns on Sunday for inspection and adjustment for about five years. It was not unusual to run for 60 days at a time without a shutdown, and interruptions to service from engine trouble were practically unknown, which speaks well for the dependability of the internal-combustion engine. Within two or three years after its installation on account of failure of the local gas supply the engine was changed to operate on oil, using a grade of distillate of approximately 38 to 40 deg. Baumé gravity.

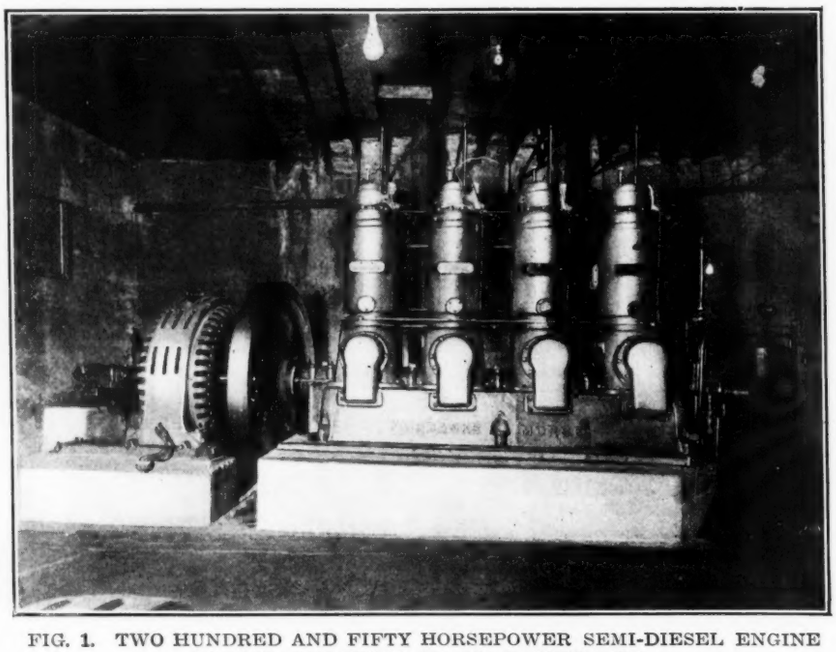


FIG. 1. TWO HUNDRED AND FIFTY HORSEPOWER SEMI-DIESEL ENGINE DIRECT-CONNECTED TO AN ALTERNATOR

Continued increase in load, due to local development and the extension of transmission lines to near by towns, necessitated increased generating capacity, and in 1916 an additional unit was installed, consisting of a 150-hp. Fairbanks-Morse type Y oil engine direct-connected to a 125-kva. generator, and in 1920 this was supplemented by the installation of a 200-hp. type Y oil engine direct-connected to a 70-kva. generator. The 200-hp. unit is shown in Fig. 1, and the simplicity of the semi-Diesel type is clearly shown in the photograph.

The oil used varies from low-grade fuel oil having a gravity of 19 deg. Baumé up to gas oil or fuel oil of 32 to 36 deg. Baumé gravity. The results secured with the type Y engine are as satisfactory with the low-gravity as with the high-gravity oil. It is customary during the warmer months of the year to burn the low-gravity fuels, as the price is usually somewhat lower than that of the lighter oils, but in cold weather, since the heavier oils are difficult to handle at low temperatures, a lighter grade is used, as the slight difference in price does not offset the difficulty of handling the low-gravity fuel. The price of oil is subject to wide variations, ranging from 2½ to 10c. per gal. delivered. The average price for the period of years covered by the operation of this plant would be in the neighborhood of 5c. per gallon. Because of the simplicity of the surface-ignition oil engines it is possible to operate for long periods without shutdown. The engines in this plant have made numerous runs of 30 to 60 days without interruption and were stopped then only for inspection and cleaning. The operating parts, aside from pistons, connecting rods and crankshaft, are confined practically to fuel-injection pumps for each cylinder. The fuel economy is good at light as well as at heavy loads, making it an ideal prime mover for an electric-light plant, which is usually subject to wide variations in load. The ability to operate successfully on almost any grade of oil available removes the difficulty sometimes experienced with engines where a certain grade of fuel must be used.

A typical log sheet covering a 24-hour period of operation on this plant shows the remarkably high fuel economy at varying loads as well as the over-all economy. The daily report shows 7 gal. of lubricating oil used. This, however, represents the amount of oil supplied to the lubricator, and as half of this is caught after going through the engine and reclaimed by means of a filter, the net amount used was only 3½ gal. The

switchboard shown in Fig 2 is equipped with indicating watt-meters for each machine, so that the actual load can easily be read at any time, regardless of the power factor.

The results shown are typical of a large number of similar installations of surface-ignition or semi-Diesel engines in small central stations. When compared with steam plants operating under similar conditions, where

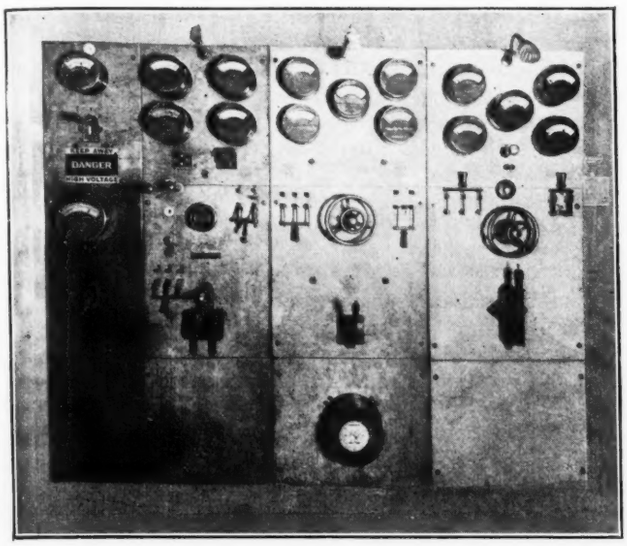


FIG. 2. SWITCHBOARD OF BONNER SPRINGS PLANT

the average output when burning oil under the boilers is only from 1 to 2 kw.-hr. per gal. of oil, and when coal fired may require 10 lb. of fuel per kilowatt-hour, it is easily seen why many light plants of moderate size have already changed over to oil engines or expect to do so as soon as the necessary financial arrangements can be made.

DAILY LOG SHEET

Thursday, March 31, 1921

	Unit No. 2												
	Engine			Generator									
Time	Fuel Oil	Lub. Oil	Water Temp.	Amp. 1	Amp. 2	Amp. 3	Kw. Ind.	Volts	Power Factor %	Reading of Watt-Hour Meter	Kw.-Hr. Output	Load Factor,%	Kw.-Hr. per Gal.
Mid.	...	..	...	..	..	..	..	....	...	7,966	..	..	...
1 a.m.	7	..	100	14	18	15	50	2,400	77	7,971	50	40	7.2
2	6	1	100	10	15	13	40	2,400	76	7,975.5	45	36	7.5
3	5.5	..	110	10	15	13	40	2,400	76	7,979.5	40	32	7.3
4	6	..	110	10	15	13	40	2,400	76	7,983.5	40	32	6.6
5	6	1	110	10	15	13	40	2,400	76	7,987	35	28	5.8
6	6.5	..	120	15	19	17	57	2,400	81	7,992	50	40	707
7	7.5	..	120	14	18	15	50	2,400	77	7,997	50	40	6.7
8	7.5	..	118	18	20	19	60	2,400	76	8,003	60	48	8
9	10	1	125	26	24	26	82	2,300	81	8,011.5	85	68	8.5
10	10	..	118	32	29	30	100	2,375	80	8,021.5	100	80	10
11	10	..	118	32	29	30	98	2,375	79	8,031	95	76	9.5
Noon	9	1	110	22	20	22	70	2,400	79	8,039	80	64	8.9
1	7	..	110	22	20	22	67	2,400	76	8,045.5	65	52	9.2
2	8	..	110	25	22	24	75	2,400	76½	8,052.5	70	56	8.7
3	8	1	105	23	22	23	72	2,400	76½	8,060	75	60	9.4
4	8	..	105	23	21	22	70	2,400	76½	8,067	70	56	8.7
5	9	..	105	23	20	21	65	2,400	73½	8,074.5	75	60	8.3
6	8	..	110	22	18	20	70	2,400	84½	8,081.0	65	52	8.1
7	10	1	110	35	37	33	135	2,400	93	8,090	90	72	9
8	9	..	110	23	25	23	90	2,400	91½	8,098.5	85	68	9.4
9	9	..	110	21	24	21	80	2,400	88	8,107.0	85	68	9.4
10	9	1	110	17	19	17	60	2,400	82	8,114.5	75	60	8.3
11	9	..	110	23	24	20	85	2,400	92	8,122.0	75	60	8.3
Mid.	9	..	100	17	20	17	63	2,400	84	8,129.5	75	60	8.3

Before starting to fire up a boiler make sure that there is plenty of water in it by trying the gage cocks. While running, do not depend on the gage glass, but try the gage cocks. The water level should be kept at a regular height and should never be less than 3 or 4 in. above the fire line, or above the top row of tubes in a return fire-tube boiler.

Oils for Power Plants

BY F. G. KLOCK

Some engineers are of the opinion that blended oils are a mixture of mineral oils and fixed oils in proportions that will thoroughly neutralize, and that compounded oils are a mixture of metallic soaps of different kinds for the purpose of increasing the viscosity. The technical term "blended oils" is used to denote mixtures in all proportions of mineral oils of various viscosities; compounded oils are mixtures of mineral oils and animal or vegetable oils, or metallic soaps. As for compounding mixtures of mineral oils and fixed oils in proportions that will thoroughly neutralize, well-refined mineral oils give a neutral reaction and fixed oils must give at least a slight reaction for fatty acids. It is, therefore, not possible, nor is it practice, to compound until a neutral indication is given.

Regarding oils for steam turbines with forced-feed or circulating systems, some engineers claim that the viscosity should be between the limits of 98 and 120 sec. Saybolt at 100 deg. F. and that lighter oils are used because they maintain their viscosities better at the relatively high temperatures. I find that of the several dozen brands of well-known oils for direct-connected turbine work, none run below 135 sec. and the average is probably 180 sec., whereas for geared turbines heavier oils are necessary, for some purposes running as high as 500 sec.

As for lighter oils maintaining their viscosities better at relatively high temperatures, although the percentage drop in Saybolt seconds is less for the lighter oils of the same crude, this fact would not operate in favor of the lighter oils.

For example, with two oils from the same crude of only five seconds difference at 100 deg. F., the heavier would be of higher viscosity throughout the entire range of temperatures up to its boiling point. Thus the viscosity relation is maintained at all temperatures for all oils from the same crude. Inasmuch as the operating temperatures in turbine bearings run between extremes of approximately 160 and 190 deg. F., the actual suitability of an oil should be determined by its viscosity at these temperatures. However, as the American Society for Testing Materials and various oil refiners have adopted temperatures of 100, 130 and 210 deg. F., at which to make viscosity determinations, this difficulty may be overcome by specifying for example: For asphaltic base oils a viscosity of 200 sec. at 100 deg. F.; for paraffin base oils a viscosity of 160 sec. at 100 deg. F. Thus, the viscosity curves of the two varieties of oils would meet in the range of operating temperatures.

Regarding the compounding of steam-cylinder oils, one writer claims that in order to obtain good results under supersaturated steam conditions, the mineral oil should be compounded with pure tallow; this is not strictly correct. Several other animal oils, among them neatsfoot and degras, are used in compounding many high-class and successful cylinder oils. As for superheated steam decomposing the animal or vegetable oil in compounded cylinder oils into glycerides and free fatty acids, the effect of any acids that might reach the cylinder wall, piston or valves, is negligible. Except in condensing ice plants, where it is necessary to effect easy separation of the oil from the condensate, the great majority of superheat installations use a compounded, high-viscosity cylinder oil.

Portland-Cement Masonry for Power Stations

By B. S. MURPHY

The advantages of the use of cement masonry for construction, betterment and repairs are set forth and a number of examples are given regarding repairs that have been made with concrete mixtures.

ONE of the most troublesome maintenance features in power-station operation is corrosion of apparatus and structure. In the stations built a decade ago little masonry was used except for the sidewalks, floors and foundations, and the major portion of this was brick; steel was used for all structural members, for air ducts, coal and ash chutes, coal and ash hoppers, with possibly some slight attempt here and there to sheath with brick. The result is that in these stations continual scraping and painting of such steel that is accessible and renewal of the plates of the ducts, hoppers, coal and ash chutes is necessary. This is to be expected when the conditions existing in power plants are considered. At the best there is a dust-laden, humid atmosphere that causes the dust to adhere to the steel, and at the worst there is strong acidic water in direct contact with the metal of such concentrations that in the chemical industries the ferrous metal would be protected by non-ferrous alloys or else earthenware.

To some extent the designing engineers have now taken cognizance of this or rather, by following modern building practice, have changed their design to utilize cast masonry to a greater extent and by so doing have accomplished the same results, so that the more modern plants are better equipped to resist corrosion. This applies more to the structure than to the apparatus, where there has been but little general change in the design. The utilization of concrete structures is becoming more prevalent year by year, and the power station itself should keep up with modern practice in this respect. But in addition to its use in designing, concrete, or rather, portland-cement masonry, lends itself to a vast number of maintenance features that apparently are not taken advantage of to their utmost in many instances.

Corrosive Action Due to Sulphur

The corrosive action found in power plants is to a great extent due to the sulphur content in the coal forming with moisture a more or less concentrated solution of sulphuric acid. The ash drippings are as a rule alkaline in place of acid, but the resultant seepage is extremely corrosive. In tidewater plants a great amount of salt water is used; here again is an active corrosive agent.

I have analyzed drippings from a coal bunker containing the steam size of anthracite and found an acid concentration as high as 1.222 grains per gallon, which would correspond to a 2.1 per cent solution of H_2SO_4, or roughly, a concentration equivalent to about a half normal sulphuric-acid solution. Such a water dripping on an ordinary cotton shirt will stain it and in a very short time rot the cloth to such an extent that a hole will appear. Plates subjected to this drip are soon pitted through. The drippings from the ash of this coal wet down with salt water, unless the incombustible content is extremely high, gives as a rule a neutral or faintly alkaline reaction, but the corrosive action has been found to be equally as severe as the strong acidic waters.

In the boiler and ash room of any plant there is a large amount of fine ash and coal in suspension in the atmosphere, which settles on all surfaces and which, when dry, is inert, but will become an active corrosive agent when it takes up moisture from the air. And of necessity the air is humid and very close to the dew point at all times, so it is not necessary to have the ferrous surface in direct contact with the coal or ash to become effective.

Cement as a Corrosive Resistant

Portland-cement mortar, when in contact with an acidic solution, will in time be reacted on and disintegrate. Also, with an alkaline water or one having a high salt content in intimate contact with a concrete or plaster mass, there will be in time a softening or disintegration due to the mechanical stresses set up in the mass by the change in volume when such salts crystallize out of solution.

The rate of this disintegration will vary with the quantity of impurities and with the resistance offered to the penetration of the liquid containing these impurities into the structure, the penetration resistance depending on the density of the concrete. For all conditions met with in power-plant work the time required for serious weakening of the concrete will be very much longer than the time required to similarly affect and pit wrought iron or steel plates or shapes, and quite some longer time than is required to cause appreciable deterioration of cast iron. From this it is apparent that the cement structure has a longer life before repairs are required, but also, this is a rather minor phase because if conditions are watched the repairs themselves are much simpler to make, and if made in a proper manner the structure can then be called as good as new and not considered as being patched.

Application of Portland Cement

Portland-cement masonry may be used in three ways and in many different forms, all having their particular advantages—cast, hand-plastered and gunite. Generally speaking, if the patch or application is to be over four inches thick throughout its whole mass, it should be cast, either about the work in forms or else pre-cast, seasoned and handled the same as stone masonry. If it is from ½ to 1½ in. thick and no cement gun is available, then it should be hand-plastered, but this as a rule gives the least satisfaction on account of its lack of density, though of course, for many locations, owing to its ease in application and the absence of special apparatus, hand-plastered mortar is ample and answers all purposes.

What autogenous welding is to the metal industry the cement gun is to masonry—it is the "putting-on tool," and its product, gunite, is the very best artificial masonry because of its great density and homogeneity. This can be used for thicknesses of from ¾ to about 4 in. ordinarily, but can be built to 12 in. in spots if necessary. The field for a cement gun in a large power

station or group of power plants is almost unlimited; it can be used for building structure, erection, alteration or replacements, for coal and ash apparatus, air ducts, chutes, hoppers and, by mixing refractory clays with small amounts of portland cement, for furnace lining.

Excluding most of the moving mechanism of a plant cement in some form can be used for repairing everything, from blowdown tanks to air lines. It has been used on a wet vacuum pump cylinder that was in such a condition that with practically the bottom of the cylinder gone the pump has been in commission for over five years.

Minor Running Repairs

A vast number of minor repairs may be made by an engine-room crew that has had no previous experience in this class of work. For instance, a blowdown tank became pitted through near the bottom. This would at the best necessitate a soft patch and, on account of its age, would very likely have to be scrapped. At the same time it was impossible to take this tank out of service. The tank was patched without even draining it.

If it is possible to take the tank out of service for a few days and work from the inside, it is very simple, but if, as is often the case, this work has to be attempted from the outside owing to small manholes or other causes, it is still a fairly easy job. Clean off the surface of the outside of the plates about where the patch is to be applied; build a rough, wooden form about the hole of such dimensions that there will be some 12 in. or more concrete on all sides, and cast a good, rich, wet mix of say 1:2, if small, or 1:2:3, with screenings for the coarse aggregate, if large, about it, puddling well. If water is draining out of the hole, as would be the case if it was impossible to completely drain the tank, then a slightly different procedure is required, for the flow of this water through the mixture would wash the cement out, making the patch worthless.

Here it is necessary to have a quick setting mixture. Build the form the same as before, but instead of using 1:2 mix with plain water, temper the mixing water with sal soda. This is done by dissolving some soda in warm water, and the addition of a small quantity of this mixture to the mortar mixed with plain water will accelerate the setting. The amount required can be ascertained by experimenting with a small quantity of the soda water, for if too much is added it will cause the set to take place so rapidly that good work cannot be accomplished. Gage the amount until the mortar becomes hard within, say, five minutes, making each batch small. Place a small drain pipe in the hole to drain the water to the outside of the form and then fill the form with the soda-tempered concrete. After the mass hardens, remove the pipe and plug the hole. This is done by enlarging the outlet of the hole through the outside of the concrete to a wedge-shaped opening, mixing up a small batch of soda-mixed cement, coneing this on a flat board so that it has about the outline of the wedge-shaped hole that has been cut, ramming this plug into the opening and bracing hard against the board containing this plaster for some 10 to 15 minutes until it has taken its set. If any leaks still exist (and it is likely that several attempts will be necessary), cut out the place where the water appears to a wedge-shaped hole and repeat. In all this work the best waterproofing for concrete itself is dense, hard, rich cement, but for certain purposes it is advantageous, and in fact, almost absolutely necessary, to place membrane waterproofing on the wetted surface of the concrete mass.

Low-pressure water lines of 8 in. or more in diameter that have corroded at the threads so that it is extremely difficult to clamp a band on the pipe, can be repaired in a similar manner. A rough temporary patch may be placed by just cleaning the metal surface, wrapping with mesh-wire reinforcements, and casting about the pipe and fitting a plain mortar, if there is no water leaking at the time, and soda mortar if water is flowing; but often it is extremely difficult to make a permanent job of this, as the vibration of the pipe line has a tendency to break the bond. A permanent job may be made by the use of membrane waterproofing. This is done by wrapping about the joint some felt or tar paper coated with hot bitumastic waterproofing or common pitch; paint the pipe before placing the paper or felt, paint the outside surface of the covering and repeat for about three laps, then cover this with a mesh reinforcement and cast the patch about the hole, puddling well to work the mortar against the wrapping.

It often happens that the bottom of a steel tank pits through although the sides are in good condition. This can be attended to very readily by cleaning out the tank thoroughly, painting the bottom and some two or three inches up the side with cement grout, and then pouring in three to four inches of a sand-cement mortar mixed wet and puddled well into the corners and against the sides. The use of a bitumastic solution on the metal before covering with grout will tend to make a more permanent job.

Major Running Repairs

The foregoing examples of patching apply to minor repairs that can be made easily, cheaply and with no special skill or equipment. I will now illustrate some of the larger uses where, of necessity, a greater degree of skill and a greater outlay are required.

Of the utmost importance in making repairs of this character is the preliminary preparation of the metal surface. The surface must be clean; there must be no loose matter or dirt adhering to it that would prevent the bond; there must be no oil or grease for this same reason, and preferably, the surface should be rough for cast or hand plaster work. Any oxidation should be removed, and the metal surface painted with red lead, for, as the rusting is progressive, if not arrested the reaction taking place between the inner surface of the concrete and the metal will, in the formation of the iron oxide, set up mechanical stresses that will physically disrupt the concrete mass and break the bond.

One of the items of a plant that is subjected to excessive corrosion is the air ducts; the action goes on as a rule on both the inner and outer surfaces, but the latter suffers more owing to the coal and ash dust in contact with the metal. The main air-duct system of a plant was suspended from the floor beams on the lower side of the boiler-room floor in the ash basement. This duct had a rectangular cross-section of 13 ft. 6 in. by 4 ft. 6 in. for 36 ft.; then by the introduction of a center partition went into two parallel ducts 4 ft. by 4 ft. 6 in. by 4 ft. 6 in. space between the inner walls for 77 ft., and finally came together as a U at the end. This duct corroded to such an extent that there was at least 20 per cent of the air leaking, and the plates had become so thin that it would not bear the weight of a man's foot. The upper surface was some twelve inches

below the boiler-room floor, so it was impossible to get at it for renewing of the plates, and the plant could not be shut down. Permanent repairs to this duct by ordinary means would be completely out of the question, but by the use of concrete it was readily repaired and the result is a duct that is better in every respect than the original.

The method of attacking this repair was to build a cement masonry duct about the existing structure, using the outside of the existing plates for the inner surface of the forms, and sealing the sides up to the boiler-room floor above; this eventually gave some twelve inches additional to the duct height. Where the duct split into two sections, it was necessary to convert this into one large duct of the same cross-section as the single duct and to make the whole self-supporting. The sides and bottom of the duct were first cleaned thoroughly and wire-brushed, beam clamps made to fit the flanges of the floor beams above with a swivel at their lower end; these were placed about 5-ft. centers and suspended from these were the center reinforcements of cast concrete girders. At one end there was a pipe line directly underneath and paralleling the center line of the duct that could not be shifted; the cross-girders located here were designed as cantilevers with a hole at their center large enough to withdraw the pipe with its vanstone flanges. The duct was then wrapped with 2-in. square mesh reinforcements and about 2 to 3 in. of gunite shot on the bottom and sides and sealed to the floor above, making side and bottom panels supported by the cast-concrete girders.

Eventually, the old plate top will be removed and the steel plate sides and bottom as they corrode enough to cause serious obstruction to the air flow, leaving a gunite duct of larger cross-section and more lasting construction.

Corroded Scrolls Shot with Gunite

At the same time the scrolls of some blowers discharging into this duct system were found to be badly corroded, so they were wrapped with wire reinforcements and shot with gunite, making to all intents and purposes new scrolls, the blowers being out of service only while the actual shooting was going on, say for some two hours at a time.

It was desired to move to a new location two steel-plate blowers that had been set originally with about half of their housing below the floor level. When the rotors were removed, it was found that the lower scroll sections were very badly corroded. Forms were built of the same contour, and concrete cast for the lower sections and the steel plates of the upper portion, which were not badly corroded, erected onto this casting. The blowers are now in service and give excellent results.

The lower section of a steel-plate storage ash hopper was found to be so badly corroded as to require all new plates, and at the same time its use could not be dispensed with for more than two days. As this hopper was suspended and had to be self-supporting as well as carrying the weight of the ashes, a cradle was made of scrap railroad rails and rod reinforcements, a wooden form built and poured, and now the old plates, inner lining of the new hopper, may corrode until they become an obstruction, when they will be cut out with an oxyacetylene torch. A smaller suspended coal hopper was repaired or really replaced in the same manner except that gunite was used in place of the cast concrete, making a cheaper and better job.

Coal chutes were completely rebuilt about the outside with gunite with no interruption to the flow of coal and eventually, when the old plates are gone, will give chutes of slightly greater cross-section.

The boilers in a plant had brick-lined, steel-plate, suspended ash hoppers. The outside of the plates became so badly corroded as to make replacements necessary. This problem was handled in two ways, cast concrete and gunite. As eventually the steel would be worthless, they had to be self-supporting, so a heavy cradle of 1-in. square rods was made with ½-in. rods interlaced with the larger ones; then for the cast hoppers forms were built and the concrete poured, while for those built of gunite no forms were needed, the gunite being shot directly onto the inside of the plates to the desired thickness. To show the advantage of this latter method, one of these hoppers, two to a boiler, 7 ft. 6 in. at the top and tapering to 18 in. at the bottom in 7 ft. 11 in., was gunited in six hours, while it required just about this time to set the forms for the cast concrete, about the same time to build the forms and from four to five hours to mix and pour.

Resistance to High Temperatures

In this same connection it may be noted that well-mixed, placed and proportioned concrete and gunite to an even greater degree will resist high temperatures very satisfactorily without the introduction of any refractory material. We have had boiler ash hoppers made in this way for over two years with very few signs of deterioration, and these principally due to mechanical spalling, where the ashmen have injured the surface with bars while poking out clinkers. In any event these minor repairs are very easy to handle, either with the cement gun or by hand, if the old surface is well cleaned, for if there should be a film of ashes or ash dust between the old and new work, spalling will take place almost immediately. Great care must be taken that green concrete is not subjected to too high a temperature for a few days, and it is well for locations where the temperature is relatively high, due to surrounding steam pipes, etc., to wet the mass two or three times a day for a day or so to prevent checking due to too rapid evaporation; this is more applicable to the hand plaster or cast concrete, for as the gunite hydrates in the air and sets almost instantly, the hydration is much more thorough owing to the very intimate mixture of the water and cement, and little care is required to prevent the heating of the new gunite.

Most of the major repairs made in the manner indicated may be considered as betterments, for, invariably, when the work is completed the repair is better than the original. But at the same time, when changes are made in an old station or new work designed, it is very advantageous to consider the use of cement masonry.

The coal spreaders for chain-grate stokers were originally made of ⅛-in. steel plate, and it was found that they became pitted through within 60 to 90 days of service. In other plants the life of such spreaders has been lengthened by the use of gray iron—clumsy affairs of great weight. We used gunite-lined, ⅛-in. steel plate with excellent results. The plates were first drilled, and on the inside wooden strips bolted over these holes to prevent their filling in subsequent operation. Mesh wire was stretched and gunite shot for about 1½-in. in thickness, the plates then assembled and the inch or so of exposed surface by the bolt holes hand

plastered. This makes an ideal arrangement and, unless pounded by the stoker operators to make the coal flow, will last for years.

It was desired to make a new coal downtake from overhead bunkers; cement-lined iron pipes were available, but there was no 45-deg. elbow. The two straight lengths were placed in position, sheet tin formed about their ends to act as an inner form, reinforcing rods threaded through the bolt holes in the flanged ends of the pipe, some hoop reinforcements woven into this, outside wooden forms built of rectangular section and cast with concrete giving an elbow that should last indefinitely; handholes were formed so as to poke free any obstruction to the coal and also to be used for the removal of the tin form when this corrodes.

The Field for New Work Is Unlimited

The field for concrete structures in the design of a new power station is practically unlimited. The foundations for the building and apparatus, the structural members, as columns, beams and girders, the floors, the outside walls of gunite on expanded metal, the roof, interior partitions, air ducts, hoppers, coal and ash chutes, bunkers, water tanks and in fact the whole building and most of the stationary apparatus can be advantageously constructed of this material in some form.

During the war it was imperative that some 200 lin-ft. of 30-sq.ft. air duct be constructed in two parallel runs, cross-connected at three places, these cross-ducts passing between 5-ft. center steel columns with lattice wind bracing. It was physically impossible to procure steel plates for this purpose, and also any plate cross-ducts would have been extremely difficult to build. Gunite for paneling and cast concrete for the heavier structural members were successfully used, and the finished work is vastly better than the accepted, standard steel duct. As the duct had to be suspended from the floor beams above, after these beams were sheathed, steel tension members were hung from them with clips supporting and framed into the side walls as pilasters; these walls to be sealed to the ceiling above and the bottom designed as a flat slab. Forms of wood covered with building paper were used for the paneling, and the air duct surface so formed is smooth enough so that the increase in the duct resistance over the steel is negligible.

In new work the first cost of gunite structures may possibly run a little higher than sheet or fabricated steel and in this way slightly bring up the capital investment; but when maintenance and depreciation are considered, this increase in the interest on investment will be counterbalanced and an appreciable net gain shown.

In major repairs to existing structures, betterments or enlargements, the gunite, supplemented by cast masonry where more applicable, will be found to be not only much simpler to construct and more adaptable, but less expensive.

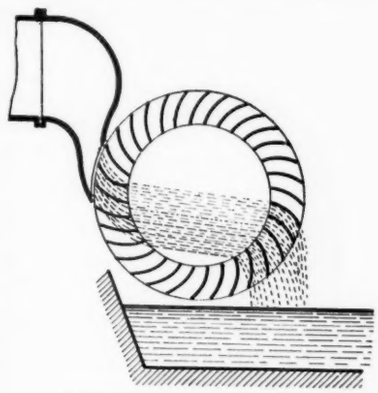
For minor repairs, especially in small plants where the work is principally hand plaster or small batch concrete, the work being done by the operating crews, the cost will be so little as to be negligible.

Any discoloring matter in water will stain a water gage glass and make it difficult to see the water level. When it becomes necessary to clean the glass use hydrochloric or muriatic acid.

New Type of Waterwheel

A new hydraulic turbine, which differs radically from both the Francis and Pelton types, has been attracting a good deal of attention recently in Europe, according to a writer in *Mechanical Engineering*. It is the invention of Professor Banki, of the Polytechnicum in Budapest. The radical feature of the turbine is that the water strikes it twice instead of but once as in the Francis and Pelton types.

As may be seen in the sketch, the water is directed against the wheel almost on a tangent; striking the blading on the near side, it gives up some of its energy and is deflected through the wheel to the opposite side, where it gives up more energy on its way out. It is necessary, of course, to have a clear space for the water to pass through, and so the wheel is made of two discs, which are held together by the blades. It is claimed that in a series of tests in Budapest on Banki turbines of varying diameters, operating under different heads and speeds, the efficiencies obtained ranged between 80 and 90 per cent. This is taken as bearing out the chief claim of superiority of the Banki turbine, which is that it will operate with the same high efficiency at low and high heads and at different speeds.



NEW TYPE OF TURBINE

Turbines of the Francis and Pelton type always have a certain fixed speed at which the most efficient operation will result and which is determined by the head of water and the diameter of the wheel. Any deviation from this fixed speed is made at the sacrifice of the unit's efficiency. On the other hand, a high speed is generally desirable, because the first cost of an electric generator decreases in almost direct proportion as its speed increases (capacity being equal). Frequently, therefore, high efficiencies are secured only by the increased first cost of a slow-speed generator.

Troubles with a Gas-Engine Oiling System

By Earl Pagett

In most large gas-engine stations the "flood" system of lubrication is used, and it is usually not a question of how many drops a minute most of the bearings shall have, but how large a stream can be delivered to the bearing.

Briefly described, such a system will consist of an elevated tank, a main distributing line, branch distributing lines to each engine to supply the individual bearings, with sight feeds and needle valves for controlling the amount of oil that each bearing receives. There will also be return pipes for collecting and returning the oil to the filters either by gravity or through pumps and to the overhead tank. Usually, there is a main suction line from the filters, with a branch to a geared oil pump on each engine, the discharge from these pumps going through a pressure accumulator into a main return to the elevated or overhead tank. Pres-

sure is also taken from the accumulators for the rams in the governors.

In one plant there were four double-acting units, each engine having its own geared oil pump driven from a bevel gear on the camshaft. Between the pump shaft and the driving shaft was a sleeve coupling with taper pins through the coupling and shaft. It sometimes happened that these pins sheared off, leaving the engine served by this pump without pressure for the ram or the governor and consequently without governing.

A bypass was laid between the accumulators on three of the engines, and when one of these pumps went wrong, it was only necessary to open the bypass, and pressure on the engine affected would be restored by the pumps on the other engines and operation continued until such time as the engine could be shut down and the pump repaired. The fourth engine, being at some distance from the others, had not been so connected and when the pins would shear on this engine, there was nothing that could be done but to block the governor and let the other engines take care of the fluctuations in the load until an opportunity came to shut the unit down.

To get around this difficulty, a bypass was put around the accumulator valve, as shown in Fig. 1, and if the pump went wrong, all that was required was to open the bypass valve and allow the tank pressure to back up in the accumulator. The tank pressure was only about half normal accumulator pressure, but it would take care of the governor after a fashion until the pump could be repaired. The sleeve coupling was finally done away with and a flange coupling substituted.

Originally, the filters in this plant were in the basement and served the double purpose of filtering the oil and separating out the water. As the plant ran only eighteen hours a day ample time was allowed for the water to settle out. Eventually, the plant was required to run twenty-four hours a day, which kept the oil on

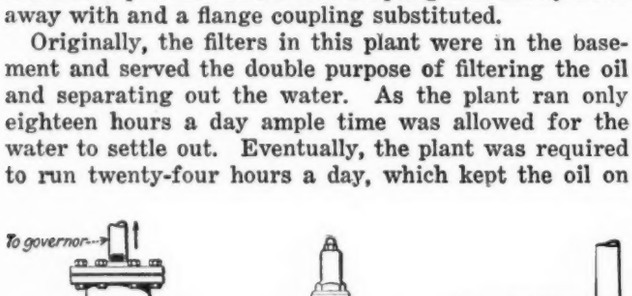


FIG. 1. BYPASSING OIL REDUCING VALVE

the move all the time, without chance for the water and oil to separate. To secure satisfactory operation, three tanks *E*, Fig. 2, ten barrels capacity were placed in the basement and the filters moved upstairs on the operating floor, where they were under the eye of the operator at all times. The dehydrating tanks discharged into a smaller receiving tank to which were connected two small motor-driven pumps for raising the oil to the filters. These pumps were in duplicate, and either was large enough to handle the oil.

As a further precaution against flooding in case the filter pumps failed to handle the oil as fast as it came from the engines, provision was made to allow the oil in the strainer tank to flow out through a check valve to the suction of the geared engine pumps in case it rose to more than a predetermined level. The oil in such event was used over and over without filtering until the filter pumps were put in shape again.

Another feature that was added was means for heating the oil so that the water would separate more readily. A pipe coil was inserted into the first tank and connected to a coil wrapped around the exhaust of the engine; a riser pipe permitted filling the line and removed any steam formed.

The oil entered through pipe *B* into the separating tank, where the water settled out of the oil and over-

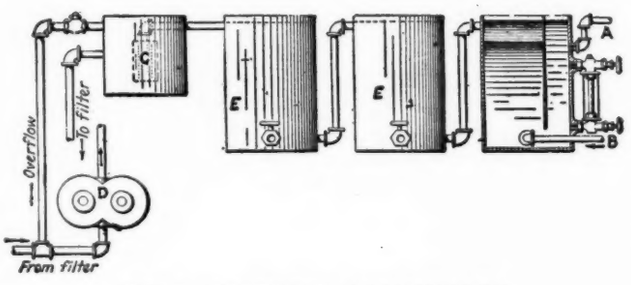


FIG. 2 OIL-FILTER ARRANGEMENT

flowed at *A*. The oil passed to the second tank, rose to the top, passed out and into the bottom of the third tank, where it again rose to the top and passed on into the filter-pump suction tank. The filter pump then lifted it into the filters for the final purification. From the filters it flowed by gravity to the geared pumps on the engines and was forced through the accumulators to the elevated tank, whence it gravitated through the distributing system over the bearings and back to the dehydrating tanks, ready to start on the cycle again. Fig. 2 shows the general layout of the dehydrating-tank connections.

A good grade of oil should be used on a gas engine and the one characteristic that it should have in particular is ability to separate from water. With the pistons, piston rods, cylinder heads and packing cages all water-cooled, some of the intricate water connections are almost sure to leak and all leakage will find its way down into the oiling system. I have seen a piston cooling-water drain-pipe break more than once, and if the operator does not happen to be where he can shut the cooling water off quickly when this happens, water runs into the oil, not in drops, but by the barrel. The dehydrating system should allow this water to escape automatically, but a certain amount will work by the separator. The second and third tanks will need draining the water out through the sludge valve every day.

The output of gasoline in this country in 1919 was 3,637,045,000 gal., valued at $679,775,500, as compared with 1,195,412,000 gal. and $106,140,200 in 1914, an increase of 204 per cent in quantity and 540 per cent in value. In fuel oils, the output in 1919 was 4,772,186,000 gal. valued at $318,082,700, as compared with 3,734,092,000 gal. and $84,017,800 in 1914, an increase of 27.8 per cent in quantity and 277 per cent in value. In illuminating oils the production in 1919, 2,304,850,000 gal., valued at $235,617,500, was an increase of 19.1 per cent in quantity and 143 per cent in value over that of 1914. The marketed production of crude petroleum in 1919 was 377,719,000 bbl., and in 1914 it was 265,762,535 barrels.

Steam Jets on Hot-Water Heating System

By JOHN C. WHITE
State Power Plant Engineer, Wisconsin

CROWNHART HALL is a dormitory operated in conjunction with the State Normal School at Superior, Wis. It is equipped with a hot-water heating system including two boilers arranged for burning hard coal. In the same block with the dormitory and about 150 ft. distant therefrom is a central steam plant used for heating the school buildings, which are in the block across the street from the dormitory. This plant is equipped with horizontal-tubular boilers with down-draft furnaces, steam pumps and other auxiliaries. The steam pressure on the boilers is carried at 50 to 60 lb. The school buildings are heated by vacuum steam systems.

War-time restrictions made it necessary to burn soft coal in the dormitory boilers, and the dirt, smoke and extra labor incident to its use were a disagreeable and expensive nuisance. It was proposed to connect the dormitory to the central steam plant and abandon the use of the dormitory boilers. The problem thus presented was capable of two solutions: Make the necessary changes in the dormitory and use low-pressure steam, or put hot-water converters and circulating pumps in the boiler room and use the existing hot-water system in the dormitory. Bids were received on both methods and the prices exceeded the funds available. The high prices of coal and labor and the poor equipment in the dormitory for burning soft coal made it necessary to do something, and the system here described was the result, primarily, of monetary limitations. It has been in successful use for three years. Ordinary commercial jet pumps, modified somewhat to reduce noise, were used the first year, and after the success of the plan had thus been practically demonstrated, it was decided to replace them with special jets made for the purpose. The latter have been in use during the last two years.

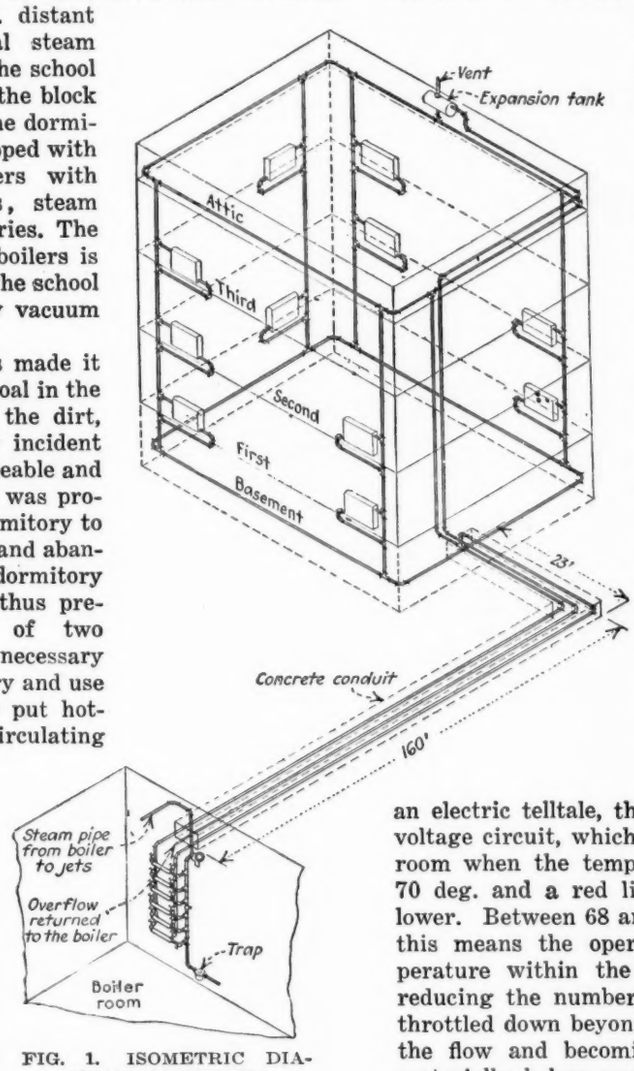


FIG. 1. ISOMETRIC DIAGRAM OF SYSTEM

Referring to the illustrations, Fig. 1 is an isometric diagram of the entire layout. The static head on the system is 47 ft. There is 6,300 sq.ft. of mostly 18-in. four-column hot-water radiation in the dormitory. The system, including mains and risers, holds about 2,000 gal. of water. The steam pressure necessary for quiet operation is 50 lb. or more. Fig. 2 shows the type of conduit used and details of steam and water connections to the jets in the boiler room. Fig. 3 is a section of the special jets showing steam and water travel, and Fig. 4 is a photographic reproduction showing the completed installation of jets in the boiler room. The extra pipe line shown in the halftone carries medium-pressure steam to the dormitory for supplying domestic hot water, laundry service, cooking and other kitchen uses. It has no connection with the heating system excepting that condensation from both is returned to the boiler room through a common return line. Fig. 5 is a curve for the guidance of the operator in determining the approximate water temperature necessary for any weather condition. For each mile of wind over 5 miles per hour, ½ deg. is added to the reading indicated by the curve. Thus if the wind velocity is 20 miles per hour, add 7.5 deg. to the temperature given by the chart. The chart was later supplemented by an electric telltale, thermostatically operated on a low-voltage circuit, which shows a white light in the boiler room when the temperature in the dormitory reaches 70 deg. and a red light when it drops to 68 deg. or lower. Between 68 and 70 deg. neither light burns. By this means the operator can control the water temperature within the desired range by increasing or reducing the number of jets in use. They cannot be throttled down beyond a certain point without breaking the flow and becoming noisy, and that point is not materially below maximum rating. The six jets give ample range for all conditions.

The report of the chief operating engineer of the plant gives the following schedule of jet operation and related data under zero weather conditions. One jet is operated from 9 p.m. until 4 a.m. to keep the water moving and prevent freezing of pipes and radiators in exposed locations. At 4 p.m. all six jets are started and the flow and return temperatures at the succeeding 15-minute intervals are given in the accompanying table.

By 6:30 a.m. the dormitory temperature is up to 70 deg. and all but two of the jets are shut off and remain so until 5 p.m.,

Steam jets used to heat and circulate water in hot-water heating system show marked economy. Noiseless operation is secured by using at least one pound of steam pressure to each foot of head in the hot water system.

when a third jet is started and run until 9 p.m. At this time two of the jets are again shut off, leaving only one in use during the remainder of the night.

On the day in question 13,250 lb. of steam passed through the jets, and according to the schedule of operation previously given, 53.5 jet-hours will pass 248 lb. of steam per hour at 50 lb. gage pressure and

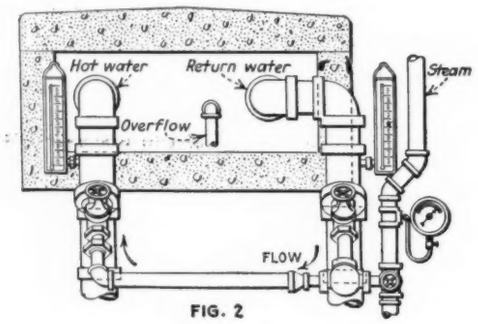


FIG. 2

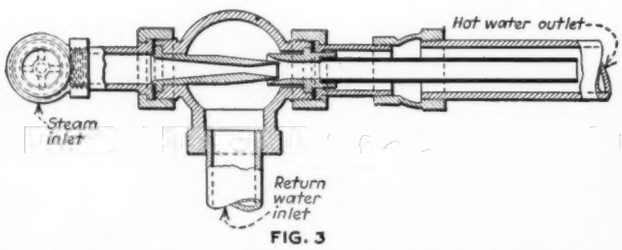


FIG. 3

FIG. 2. STEAM CONNECTIONS TO HOT-WATER PIPING AT MOUTH OF CONDUIT. FIG. 3. SECTIONAL VIEW OF ASSEMBLED JET

against a total hydraulic head of approximately 50 ft. The heat transferred per pound of steam under the foregoing pressure conditions and with an average return-water temperature of 154 deg., is equal to the sum of the latent heat and the heat of the water, or 911 + 144 = 1,055 B.t.u.

FLOW AND RETURN TEMPERATURES

Time A.M.	Temperature of Flow, Deg. F.	Temperature of Return, Deg. F.	Temperature Difference, Deg. F.
4:15	120	80	40
4:30	142	92	50
4:45	152	102	50
5:00	160	112	48
5:15	164	120	44
5:30	170	128	42
5:45	178	136	42
6:00	184	142	42
6:15	190	148	42
6:30	198	154	44
Average			44.4

The total heat exchange per jet-hour is therefore 248 × 1,055 = 261,640 B.t.u. and for two jets, 523,280 B.t.u. The heat required to warm the building in zero weather, according to Carpenter's formula, was computed at approximately 500,000 B.t.u. per hour. Since two jets are ample to do the work after the circulating water and the building have been raised to normal temperatures, the theoretical deductions are verified in actual practice and there is little chance of serious error in the jet capacities as previously computed.

It has been shown that 523,280 B.t.u. per hour was the quantity of heat delivered to the system and that it was dissipated through 6,300 sq.ft. of active radiation. The rate of emission, therefore, is 523,680 ÷ 6,300 = 83.1 B.t.u. per square foot per hour. The average temperature difference between the water and the rooms is probably about 80 deg., and on this basis the emission per square foot per degree difference per hour amounts to 83.1 ÷ 80 = 1.04 B.t.u. Under the conditions as represented, each jet will supply about 3,000 sq.ft. of radiation. It should be stated here that there is an excess of radiation in the building.

As to results the building is heated comfortably under all weather conditions with a minimum waste of heat, and so long as the steam pressure is kept at 50 lb. or higher, there is no noise. If the pressure is allowed to drop much below 50 lb., the jets "break" and the noise is carried in all its disagreeable features to the extreme ends of the system. There is no reason for letting the steam pressure fall below 50 lb., but it does happen at times. It was found by experiment that to secure noiseless operation there must be at least one pound of steam pressure for each foot of head in the hot-water system.

The jets were designed and experimentally adjusted until they were noiseless at all steam pressures from 45 to 110 lb. gage and with water temperatures ranging from 60 to 215 deg., the hydraulic head being constant at 47 ft. The report on the dormitory for January, 1920, showed a consumption of 2,900 B.t.u. per cubic feet of space for the month. The lowest consumption in a steam-heated building of comparable size and service was 4,020 B.t.u. for the same month. The difference, approximately 25 per cent, should be credited to the better control of temperatures and consequent saving therefrom which are inherent features of hot-water heating. The jets have nothing to do with economy excepting as they permit accurate control of temperatures.

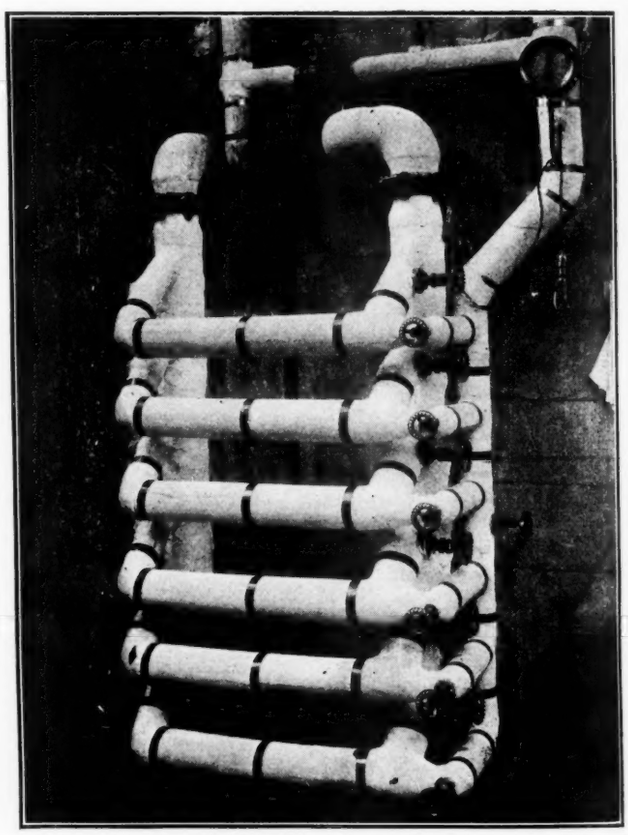


FIG. 4. COMPLETE INSTALLATION OF JETS IN BOILER ROOM

Advantages claimed for this system are: It enables the hot-water system to be served from the central plant at a minimum cost and with complete satisfaction; the jets impart sufficient movement to the water so that circulating pumps are not required; control is centralized in the heating plant and its range is sufficient for all conditions; the condensation of the steam passing the jets keeps the system at all times full of pure water

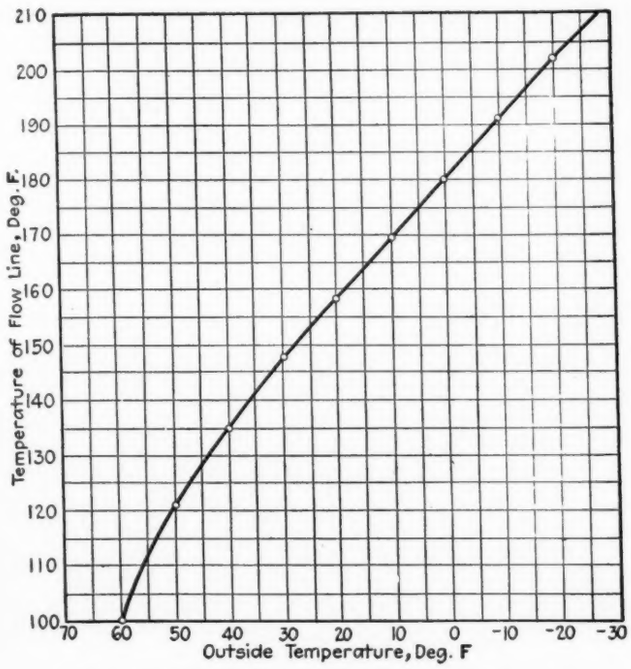


FIG. 5. TEMPERATURE CURVE FOR OPERATING HOT-WATER SYSTEM

and the overflow from the expansion tank is a daily measure of the steam supplied to the system; it can be metered or weighed and the service charge based on the quantity thus determined.

Some of the disadvantages are: Low-pressure steam cannot be used, so that the system in its present state of development is inapplicable where exhaust steam is the heating medium; disagreeable noise results from too low steam pressure.

The success of the installation is due in large measure to the co-operation of Maurice Hoover, chief operating engineer at the plant, and credit is due him for the installation of the electric telltale, previously described, and the automatic control of furnace draft now in use.

James Richardson stated, at a meeting of the Institution of Engineers and Shipbuilders in Scotland, that theoretically it should be possible to produce a Diesel engine of small power for approximately 10 lb. weight per brake horsepower developed. The actual weight of the lightest engine as yet constructed is, however, between 50 lb. and 60 lb. per brake horsepower. The highest speed of revolution at which the Diesel engine can be run is an unknown quantity. When, during the shop trials of a high-speed engine the governor broke down, the speed of the engine, which was normally 450, rose to nearly 700, and the engine continued to run for the twenty-four hours necessary to complete the trial, as steadily and as well as when running at the lower speed.

Economical Operating Limits of the Refillable Fuse

By Philip C. Jones

In spite of opposition on the part of many engineers and lack of support from the Fire Underwriters, the use of the refillable fuse has increased enormously, and at the present time practically all fuse manufacturers are putting out refillable fuses, and the Underwriters have approved them. The cause of the great demand for the refillable fuse is the apparent economy of replacing the fuse ribbon only in case of a blow, instead of the whole fuse.

However, the writer is inclined to believe that the use of the refillable fuse has already passed its economic limit. Several factors must be considered in deciding on the type of fuse to be used, such as safety, reliability, simplicity, etc.; but probably the paramount factor is economy. The question of whether refillable fuses pay from the viewpoint of dollars and cents may readily be put into a form making it possible to find a correct answer with a minimum of effort.

Using the following notation, some simple equations may be developed.

C = Fuse operating cost per year.
F = List price of fuse.
R = List price of refill or replacement of fuse.
p = 1 — the discount expressed as a decimal fraction. When the discount is 20 per cent, p is 1 — 0.2 = 0.8.
N = Number of blows per year.
K = Number of fuses in service.
P = Number of blows per year per fuse in service; that is, $\frac{N}{K}$
I = Interest value of money.
r used as a subscript stands for refillable.
n used as a subscript stands for non-refillable.

The yearly operating cost of fuses, C, is equal to the cost of the replacements plus the interest on the money invested in the fuses installed. Thus we have for the refillable fuses,

$$C_r = KIpF_r + NpR_r = p\,(KIF_r + NR_r) \qquad (1)$$

and for the non-refillable we have similarly,

$$C_n = KIpF_n + NpR_n = p\,(KIF_n + NR_n) \qquad (2)$$

These are equations in one variable N. Since the refillable fuse is always more expensive than the non-refillable type, equation (1) will be greater than (2) when N is zero or very small. On the other hand, it costs more to replace a non-refillable fuse than to refill the refillable type; therefore equation (2) will be greater than (1) when N is very large. Equating (1) and (2) and solving for N gives the point where either type might be used with equal economy. For smaller values of N the non-refillable should be used, and for larger values the refillable fuse.

Equating we have:

$$p(KIF_r + NR_r) = p(KIF_n + NR_n)$$

or

$$NR_n - NR_r = KIF_r - KIF_n$$

Therefore

$$\frac{N}{K} = P = I\,\frac{F_r - F_n}{R_n - R_r}$$

Thus for a given number of fuses in service, the minimum number of blows per year which admits the use of refillable fuses is directly proportional to I, the

interest cost of money. It should also be noted in passing that the factor p drops out of the foregoing equations, so that the result is the same regardless of the discount a consumer is getting.

The values of the expression $\frac{F_r - F_n}{R_n - R_r}$ have been computed for all sizes of cartridge fuses up to 600 amperes for both 250- and 600-volt ratings and are listed in the table.

ECONOMIC LIMIT OF USE OF REFILLABLE FUSES

Number of blows per fuse per year above which refillable fuses should be installed, when interest value of money is 10 per cent.

Minimum number of blows per fuse per year $= \frac{F_r - F_n}{R_n - R_r} \times$ interest

Fuse Ratings	Amp.	List Price Non-Refillable Fuse F_n $ Each	Replacement Cost Non-Refillable R_n $ Each	List Price Refillable Fuse F_r $ Each	Cost of Refill R_r $ Each	$\frac{F_r - F_n}{R_n - R_r}$	Minimum No. Blows per Fuse per Year P
250-Volt Fuses	30	0.20	0.20	0.50	0.03	1.36	0.136
	60	0.30	0.30	1.00	0.05	2.00	0.200
	100	0.90	0.60	2.00	0.10	2.20	0.220
	200	2.00	0.90	4.00	0.15	2.67	0.267
	400	3.60	1.50	7.50	0.30	3.25	0.325
	600	5.50	2.00	11.00	0.60	3.93	0.393
600-Volt Fuses	30	0.40	0.40	1.10	0.05	2.00	0.200
	60	0.60	0.60	1.25	0.06	1.19	0.119
	100	1.50	0.80	3.00	0.10	2.14	0.214
	200	2.50	1.20	5.00	0.15	2.38	0.238
	400	5.50	2.00	11.00	0.30	3.23	0.323
	600	8.00	3.00	16.00	0.60	3.33	0.333

The first four columns of the table give the present list prices, the fifth gives the value of the ratio $\frac{F_r - F_n}{R_n - R_r}$, and the sixth gives the number of blows per year per fuse in service necessary to warrant the use of the refillable fuse when I is 10 per cent. The use of the table is illustrated by the following example:

(a) Given a plant equipped with two hundred 60-ampere 250-volt non-refillable fuses and seventy-five 400-ampere 250-volt fuses of the same type. These fuses have been blowing at the rate of 55 blows per year on the 60-ampere size, and 19 blows per year on the 400-ampere size. Would it be advisable to change to refillable fuses in this case, the interest value of money for this concern being 10 per cent?

The number of blows per fuse per year on the 60-ampere size is 55 divided by 200, or 0.275. From the table the minimum figure for 60-ampere fuses is 0.200. Therefore refillable fuses would be more economical for the 60-ampere size. The number of blows per fuse per year on the 400-ampere size is 19 divided by 75, or 0.253. From the table, the minimum figure for 400-ampere fuses is 0.325. Therefore, the refillable type would be more costly to operate in this size, and non-refillable fuses should be retained.

(b) In the foregoing example, let money be worth 15 per cent instead of 10 per cent, to this particular concern. Then, the minimum number of blows per fuse per year $= I \frac{F_r - F_n}{R_n - R_r}$. From the table, $\frac{F_r - F_n}{R_n - R_r} =$ 2.00 for 60-ampere fuses and 3.25 for 400-ampere fuses. Therefore the minimum number of blows per fuse per year will be $2.00 \times 0.15 = 0.300$ for 60-ampere fuses and $3.25 \times 0.15 = 0.487$ for 400-ampere fuses. Both these values are higher than the actual rate of blowing. Therefore, at 15 per cent interest non-refillable fuses in both sizes would prove more economical in the plant under consideration.

With the exception of the 60-ampere 600-volt size the number of blows per fuse per year increases with the increase in size from about 0.12 to nearly 0.40. Thus the larger the fuse the less likelihood that a refillable fuse will be warranted. This is emphasized by the fact that there is always a smaller percentage of blows in the large fuses.

While a value of 10 per cent for I is fair enough for an average case, in many cases it may be too low. To a manufacturer money is worth what he can make on it, and this may be considerably more than 10 per cent.

It is not the purpose of this article to argue in favor of either type of fuse, but merely to point out that it cannot be taken for granted that the refillable fuse is cheaper under all conditions, and that a little investigation is well worth while before deciding on the use of either the one or the other.

Ridgway Mixed-Pressure Turbine Governor

In operating a mixed-pressure turbine, there is frequent failure of sufficient low-pressure steam from the non-condensing engine or other source of supply. It is desirable to use all the available low-pressure steam and to make up the deficiency with high-pressure steam. A suitable governor is, therefore, necessary to control the admission of both low- and high-pressure steam.

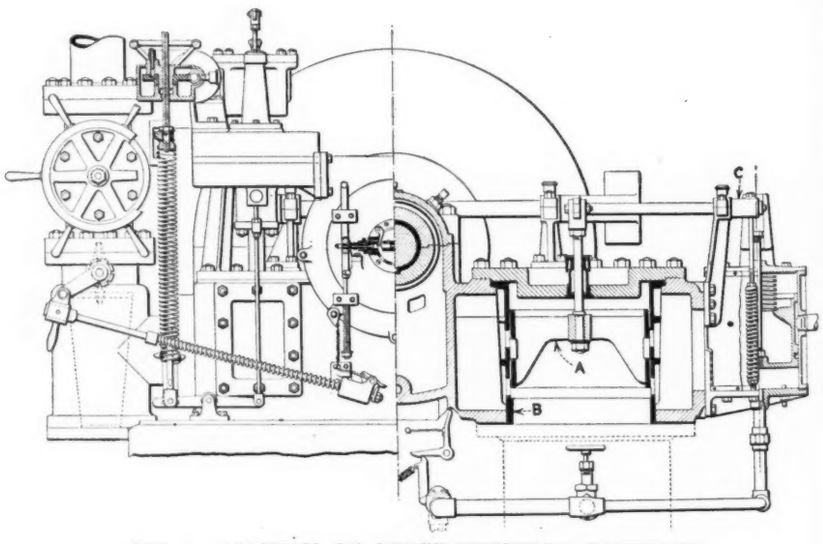


FIG. 1. DIAGRAM OF MIXED-PRESSURE GOVERNOR

A pneumatic governor designed to control both high- and low-pressure steam on mixed-pressure turbines has been developed by the Ridgway Dynamo and Engine Co., Ridgway, Pa. This governor is similar to that used for high-pressure turbines, described on page 300 of the Aug. 19, 1919, issue of *Power*, but has in addition what is termed a selective mechanism, which is placed between the oil-control cylinder and the high-pressure valve stem. Details of the selective mechanism

are illustrated in Fig. 1, and its operation is shown diagrammatically in Figs. 2, 3, 4 and 5. Fig. 6 shows the governor as applied to a mixed-pressure turbine.

When sufficient low-pressure steam is available to carry the load, its pressure will force the piston *A*, Fig. 1, up in the selective cylinder *B*. By means of the connecting bell cranks *C* this movement throws the high-pressure link block *D*, Fig. 2, over the fixed center of the link, so that any movement of the governor affects only the low-pressure admission valve *E* and no high-pressure steam is admitted.

If the low-pressure steam supply is not sufficient to carry the load, its pressure falls and the piston in the selective cylinder lowers and the movement throws the low-pressure link block *F* over the fixed center of its link, and the high-pressure link block moves over so as to open the high-pressure valve, Fig. 3.

For a partial supply of low-pressure steam the piston in the selective cylinder and the links and link blocks assume an intermediate position and the load is carried by the available low-pressure steam, the deficiency being made up by high-pressure valves being open, as shown in Fig. 4.

The governor is so designed that changes in the relative supply of high- and low-pressure steam causes no perceptible change in speed as the links shift from one position to another. Fig. 5 shows the low-pressure valve open and the high-pressure valve closed, the turbine running wholly on low-pressure steam.

The emergency trip on a mixed-pressure turbine is identical with that used for a high-pressure turbine, with the addition of a latch and quick-opening gate valve that is operated by the main trip rod. When the trip operates, the pressure in the selective cylinder is

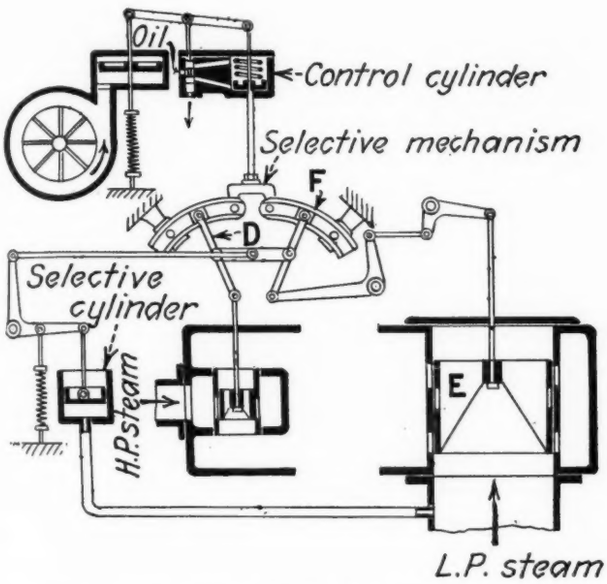


FIG. 2. BOTH HIGH-PRESSURE AND LOW-PRESSURE VALVES CLOSED

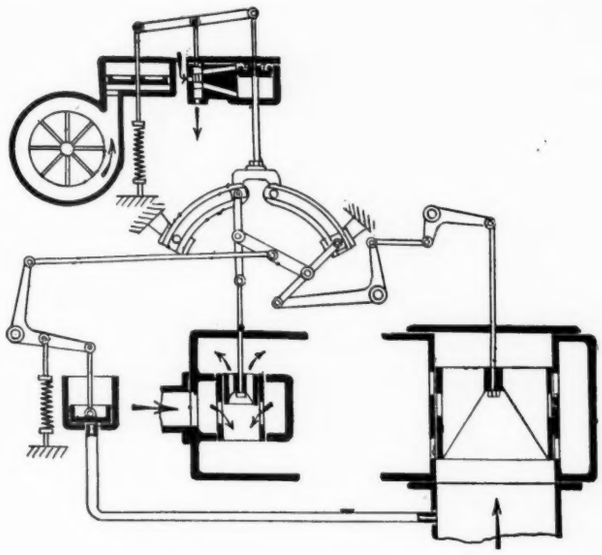


FIG. 3. HIGH-PRESSURE VALVE OPEN, LOW-PRESSURE VALVE CLOSED

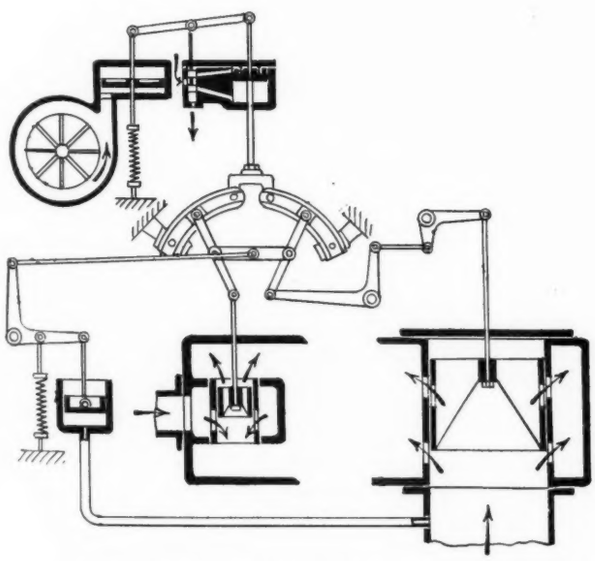


FIG. 4. BOTH HIGH-PRESSURE AND LOW-PRESSURE VALVES OPEN

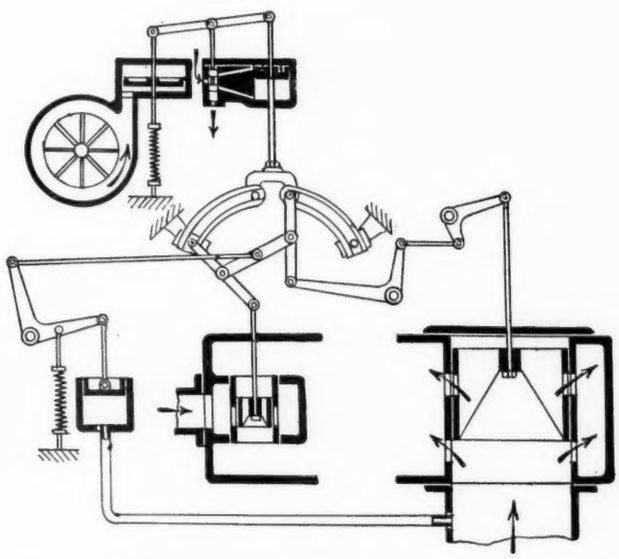


FIG. 5. LOW-PRESSURE VALVE OPEN, HIGH-PRESSURE VALVE CLOSED

released, which causes the piston to descend and throw the low-pressure valve out of action and into its closed position, thus protecting the turbine from overspeeding on either high- or low-pressure steam in case the turbine approaches a dangerous speed.

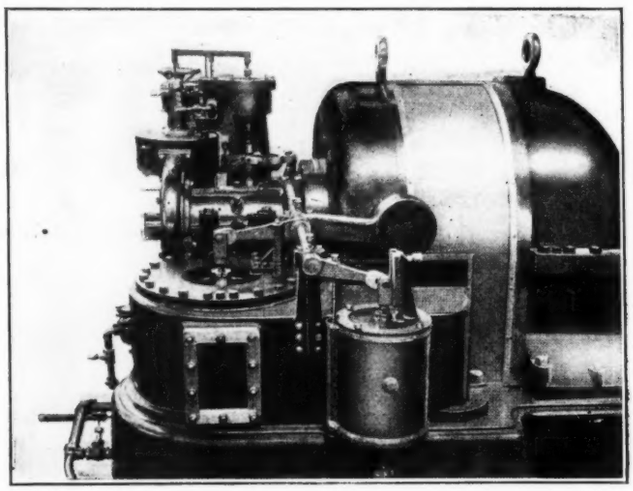


FIG. 6. MIXED-PRESSURE GOVERNOR TURBINE

This arrangement constitutes a positive and simple governing system for use in mixed-pressure turbines even with fluctuating load and steam supply.

Multiple Operation of Alternating-Current Generators

By Eustis H. Thompson

While alternating-current generators are not troubled by the delicate adjustments of brush shift, series-field resistance, equalizers, etc., as are direct-current generators, their multiple operation hinges on the action and adjustment of the turbine governor to a much greater extent than in direct-current machinery. The division of the station load between the different machines from no load to full load depends on the amount of steam that the governors admit to the turbines when the machines drop a certain percentage in speed. Since alternators must be operated in synchronism, it follows that when the load comes on the station and the frequency is lowered, each machine will drop the same percentage of frequency, or in other words, an equal percentage in speed. If two alternators are running in parallel and one of them has a regulation of 4 per cent, so that its full-load speed is 4 per cent lower than no-load speed, it will carry twice as much load as the other machine of the same size, if the regulation of the latter is 8 per cent. Large and small sets that have the same regulation pull loads in proportion to the amount of steam admitted by their valve gear, so that the small unit will have less torque tending to drive the generator on account of its smaller steam turbine. Other conditions, such as reactance of generator windings, resistance of the main leads, etc., seldom have any appreciable effect on the division of the load in practical work.

Most alternators have hand or motor-driven attachments on the governor for varying the speed, so that the machine can be slowed down to full load speed for connection to the busbars when full load is on the other machines, and then speeded up so as to take its share of the load from the other machines and thereby allow them to speed up slightly. Since it is possible to equalize the load distribution by hand adjustment, it is not necessary to have the same governor regulation from no load to full load on all the machines. Such a condition, however, does not represent the best condition for practical operation; if the station load should shift to a very large extent when the operator does not happen to be present, it might result in some of the machines being overloaded and blowing their breakers, with the result that the others would then receive the load and open their breakers in turn. Also, when the load drops off, the machine that has the closest regulation will carry less than its share of load and might possibly be motorized, while the machine with the largest regulation will take up most of the station load, including the power drawn by the motorized units.

Machines Should Have Same Governor Regulation

There is another reason for setting all the station governors as near equal regulation as possible. The speed-changing device is usually of such a nature that it acts with the governor spring or against it and produces a thrust that imposes an additional load on the governor bearings; this should be eliminated if possible, by operating at the governor speed where the speed-changing mechanism is not called into service. If the governor regulation of all machines is properly adjusted to the same amount, these devices should remain in a neutral position in ordinary operation and be used only for the purpose of changing the speed of the machine when it is placed on the line or taken off. The actual speed regulation, and therefore the load distribution between the machines, will in that case rest on the adjustment of the governor itself, so that much less attention and possibly none at all will be required on the part of the operator for the regulation of the load.

Other multiple-operation troubles, such as surging or cross-current from one machine to the other, are in practically all cases due to friction or lost motion in the governor or valve gear. Characteristics of such surging are practically the same as in the case of direct-current generators.

Turbine units usually run in parallel with steam engines without any difficulty. If the engine flywheel is too light, a cross-current or surge will be noticed at every stroke of the engine. Some forms of engine governors, such as a shifting eccentric, are sometimes inclined to operate more freely on certain portions of the engine cycle and therefore cause a slight surge at this time, which may or may not vary with the load carried. But a steam engine in proper condition should give no trouble in multiple operation.

The same applies to gas engines except that such machines are more sensitive to misadjustment. When an explosion is missed, a very large surge of current can be expected.

In his annual report to the Manchester (England) Steam Users' Association, Mr. Stromeyer, the well-known English authority on boilers, contends that the hydraulic testing of steam boilers should be abandoned. He quotes many instances where boiler explosions have immediately followed "satisfactory" hydraulic tests and advances the theory that the strains produced by the tests may have contributed to the final failure. His claim that the hydraulic testing of boilers "is at the best superfluous, often misleading and at times actually harmful" will doubtless cause a great deal of discussion.

EDITORIALS

An Unusual Engineering Expedient

THE extent to which we are dependent for service upon the great and complex machine of modern industry is never so forcibly brought home to us as when the machinery either breaks down or becomes diverted to other uses than ours. The war, by monopolizing the larger part of the manufacturing forces of the world, placed many concerns at the parting of the ways, where it behooved them either to fall in line and change their business from peace to war-time activities, or to revert to old-time methods of makeshift engineering wherein ingenuity, resourcefulness and courage must be relied upon exclusively, and the daily problem is how to make something out of nothing.

Such an expedient is described in this issue under the title of "Motor-Generators Rebuilt from Corliss-Engine Units." The Winnipeg Electric Railway Co. experienced great trouble from electrolysis during 1918, and it became imperative to change to three-wire operation. How this was accomplished in the face of the practical impossibility of obtaining the necessary generating equipment from manufacturers is the subject of this article. Old engine-driven units long since out of use and over twenty years old were combined into motor-generator sets and given a new lease of life. With the slogan of "economy" ever ringing in their ears, many concerns might well, even in these piping times of peace, give serious consideration to this use of obsolete equipment.

Niagara the Nucleus of a Superpower System

NIAGARA FALLS is one of the greatest and one of the most favorably located water-powers in the world. Not only have large industries been economically located at the Falls, but there are within economical transmission distance of Niagara Falls industries, which require millions of horsepower. The normal continuous flow of the Niagara River is about two hundred and ten thousand cubic-foot-seconds. Of this flow it has been recommended by Government engineers that only eighty thousand cubic-foot-seconds are required to maintain the scenic beauty of the Falls, leaving one hundred and thirty thousand cubic-foot-seconds available for power purposes. When this is utilized under the full head of three hundred and fourteen feet it will develop four million horsepower, not considering the power that may be developed in the St. Lawrence district. If only half of this is available in this country, it will give an inexhaustible supply of two million horsepower, of which only about one-sixth has been developed. When Niagara's four million horsepower are fully utilized, it will result in an equivalent annual coal saving of approximately thirty million tons.

In past years conditions, due to Governmental restrictions and otherwise, were not of a nature to encourage the development of Niagara's power, consequently this work lagged. However, many of the objectionable features have been removed and the probabilities are that vast power development will take place at Niagara, as fast as plants can be built and markets for the power provided.

In the past a large percentage of Niagara's power has been required by industries that have grown up around the Falls. With many of the restrictions removed, there is little doubt that power development at the Falls will fast outgrow industrial development and large markets for this power will have to be obtained elsewhere. In a paper on "Hydro-Electric Development at Niagara Falls," by John L. Harper and J. A. Johnson, presented before the annual convention of the American Institute of Electrical Engineers, the authors expressed the following opinion:

> It must be borne in mind that the attainment of our highest good must ultimately demand the most efficent use of this power. Nor is efficiency here meant in any narrow sense, but in the broadest sense of the greatest good to the greatest number. Within the next few years we shall undoubtedly see great superpower transmission lines reaching out hundreds of miles from Niagara, putting here surplus power to work, but as the years roll on and the growth of our population creates increasing demands for the peculiar products of Niagara's particular genius, we shall see this energy distribution gradually being drawn in. And creeping after it we shall see great steam plants slowly but steadily approaching Niagara, replacing in the homes and secondary industries that energy which, as time goes on, can less and less be spared from the home industries of Niagara.

Since Niagara's water cannot be stored as is done on many other water-power developments, its most economical use must be to carry a base load. Under such conditions, as Niagara's power system extends out, existing steam and hydraulic plants will become stand-by and peak-load stations, the hydro-electric plants that have storage facilities being utilized to carry peak loads. The realization of the foregoing will go far toward eliminating the waste of our fuel resources.

The Salesman an Educational Force

IN MANY power plants the engineer in charge has frequent opportunity to talk with salesmen who are selling everything from packings to steam turbines. These visits are a source of pleasure sometimes and sometimes of annoyance to the man sought out by the salesmen. It may be that the "prospect" sometimes wonders whether the time he thus spends is on the whole profitable to the plant and to himself personally.

Leaving out of consideration for the moment the pleasure that most men find in "talking shop" occasionally, it is worth while to consider some of the fundamental motives which underlie the actions and conversation of both salesman and "prospect." The salesman's primary aim is to keep his earning capacity at the highest possible point. This means that the present and future welfare of the company that he represents

must be constantly in his mind. His company naturally desires the greatest possible volume of current sales, and unless it is of the "fly by night" variety, it also desires, as the only foundation for future business, the complete satisfaction of all its customers. This means that it wishes the customer to install its equipment only where the transaction will prove mutually and permanently profitable. It also means that a great deal of service must be given to insure the proper selection and use of equipment. If a customer, even though it be entirely of his own volition, selects any but the most suitable equipment or operates suitable equipment in an inefficient manner, the resulting "black eye" which the manufacturer gets often far outbalances the immediate money profit from the sale. Therefore, even if the moral considerations are neglected, it is decidedly to the advantage of the manufacturer to give the customer real value and service.

For this reason the average salesman of power-plant equipment must frequently act the part of a consulting engineer. Sometimes he is broadly qualified for such work, but even where he lacks the broader experience and knowledge, he has available, if he is at all worthy of the name of salesman, a considerable knowledge of his specialties and their applications. His information may sometimes be colored by prejudice in favor of the products that he has to sell, but this need involve no great danger to the engineer who knows his business.

The engineer, like the salesman, is anxious to make good at his job and to advance both in earning capacity and in the respect of his associates. His success, also, must depend very largely on his real value to his employers, and this, in turn, will be measured by his ability to deliver the best quality of power service at the lowest total cost for overhead and operating expenses. To do this, he must keep his mind open to every possible suggestion that may be of assistance. He probably will find that he simply cannot afford, either for his own sake or that of his employers, to get the habit of dismissing salesmen without giving them a hearing. The wheat obtained in this manner will contain some chaff, but it is unwise to throw away the wheat to avoid the chaff. One who is afraid to listen to a salesman's best arguments confesses his own weakness. He admits that he cannot safely make the decision because he is influenced chiefly by the last argument heard rather than by the combination of all he has previously learned taken in connection with new facts placed at his disposal.

The engineer of balance and judgment will gladly listen to the arguments of all who have some knowledge of that whereof they speak. He will do this even if he feels that some of the claims advanced are doubtful. He will then compare the conflicting claims, using in the process all the knowledge and experience he has been able to accumulate, supported by all that he can dig out of technical books and papers and other disinterested sources of information. On some points he will find no disagreement and there decision will be an easy matter. Where important differences occur, he will at least be able to decide that the truth lies between certain limits.

The final result will be that his decisions will be of more value to his employers and that he himself will be a better equipped engineer for having listened to all sides. This training will cost him no money. It will involve only a reasonable expenditure of time and the relinquishing of any foolish pride he may have in his own infallibility. The latter will be easy when it is remembered that a man can listen with open mind without permitting himself to be swept off his feet by a torrent of new ideas.

Steam Valves

IT IS not an easy matter to furnish valves to meet the exceptional demand imposed by steam lines employing high pressures and high superheats such as are becoming standard practice. It is said that none of the valves in the steam lines of one of the newest central stations is as tight as would be desirable.

When steam pressures were first increased some years ago, semi-steel valve bodies were tried, as cast iron was found unreliable under the higher pressures and temperatures. Later, it was found necessary to use cast steel and this is still standard practice for high pressures and superheat. In fact, in some places only steel is permitted where superheat is used. Monel metal is now universally employed for the seats and the faces of discs of gate valves for severe service conditions. Standard gate valves are generally used in this country on steam lines, although in England the Hopkinson-Ferranti valve with venturi-shaped body is used extensively and is said to give good service. On the Continent globe valves are most commonly used, their disturbance of the steam lines being tolerated on account of their greater resistance to distortion.

Opinions differ regarding the merits of the solid or double-disc for gate valves. An important factor in valve design is the provision of proper guide wings so that the disc does not touch the seat until the steam is virtually cut off. If the valve comes in contact with the seat before it is fully closed, it will often be found impossible to close the valve without scoring the seat. In fact, it is a question whether some valves can be closed at all without twisting off the valve stem when full boiler pressure acts on one side of the disc and atmospheric pressure or vacuum on the other side. Such a situation might occur when the main steam valve to a turbine needed to be shut down owing to a failure of the turbine control valve. Unless the disc guides provide for free travel and the disc goes into place without coming in contact with the seat, trouble will be encountered in closing a valve under these conditions. In some cases small bypass valves are provided on the main steam valve, and these lessen the troubles of opening and closing the large valves. Furthermore, if there is any tendency for the valve body to distort under high pressure and temperature, added complications will result. Steel valve parts require careful annealing before being finally machined. Great care should be taken in design to meet these extreme conditions. Electric-furnace steels are now extensively used for valve bodies.

Central-station engineers realize that higher efficiencies are possible with higher steam pressures, especially in connection with high superheats, and invite troubles in the steam-transmission system which may offset all the advantages gained. Valve manufacturers have been courageously attacking these new problems and, through skillful design and the intelligent choice of materials, have made considerable progress toward their solution. The boilermakers are ready to build to the higher pressures, and there is reason to believe that the valve manufacturers will not long allow their products to be the limiting factor.

CORRESPONDENCE

Are Small Boiler Tubes Desirable?

On page 902 of the May 31 issue C. J. Miller presents figures of test results in a comparison of similar return-tubular boilers with 3½-in. and 4-in. tubes, which are very interesting; and although one would naturally expect the boiler having the smaller tubes to show a higher efficiency aside from its advantage in tube-heating surface of 1,418.4 sq.ft. as against 1,319.5 sq.ft., such a large percentage difference as shown seems hardly to be attributed to the difference in diameter of the tubes alone. The rating developed, 117 per cent on the basis of their nominal capacity, is not excessive, and the coal burned per square foot of grate per hour, 24.1 lb. for the 3½-in. tube boiler and 28.4 lb. for the 4-in.-tube boiler, seems about as high as could be obtained with the 0.22 in. draft carried in the furnace. It is possible that at times there was insufficient air supply and incomplete combustion. As the coal used was presumably the same with both boilers, we may construct a tentative heat balance for the tests as follows, assuming for the moment that there was no incomplete combustion and no CO formed, the figures given for the various losses being about an average for this type of equipment, but not mattering greatly since they are taken the same for both:

Item	Boiler with 3½-In. Tubes, Per Cent	With 4-In. Tubes, Per Cent
Heat lost in latent heat of hydrogen	3.0	3.0
Heat lost in unburned CO, etc.	0.0	0.0
Heat lost in unburned carbon in ashpit	8.0	8.0
Heat lost in radiation and unaccounted for	10.0	10.0
Heat used in evaporation	62.5	53.1
	83.5	74.1
Balance—heat lost in chimney gases	16.5	25.9
	100.0	100.0

Assuming the same CO_2 of 10 per cent in both cases, corresponding to an excess air percentage of 75, the heat loss up the stack would be about 3.34 per cent of the heat of the coal for each 100 deg. flue temperature above the boiler-room temperature; or assuming this to be 80 deg. F., the temperature rises would be respectively 494 and 776 deg. F., or the flue temperatures respectively 574 deg. F. and 856 deg. F.

It seems unreasonable to believe that, other things being equal, the difference in the size of the tubes would have caused over 280 deg. difference in flue temperature due to improved heat absorption. Therefore I believe that if data for compiling a complete heat balance for each boiler had been available, it would have been found that the difference in efficiency was due more to differences in the factors under the control of the fireman; that is, to the ashpit losses and flue-gas analyses rather than to the flue temperatures, which are the variables chiefly affected by the size of the tubes.

I believe that the only disadvantages of small tubes are where draft is limited, the additional choking due to small tubes, and the increased difficulty of cleaning. This, however, is not serious and can be minimized by setting the boilers high enough above the grates to allow of proper combustion before the gases enter the tubes, so that the soot will be completely burned and none left to form the fluffy black deposit usually found, which forms such an excellent heat insulator.

How thorough an insulator soot is, was strikingly demonstrated in one plant where the flue temperature was reduced from 750 to 520 deg. on the average by a thorough inspection to see that the fireman cleaned out the tubes as his orders called for.

New Haven, Conn. H. D. FISHER.

Molecular Attractions of Contact

After reading with much interest the abstract "Molecular Attractions of Contact," page 408 of the March 8 issue, I am reminded of an experience I once had with a bearing that was "too good" to run. This particular bearing was 22 in. long on a 10-in. diameter shaft and was the outside high-pressure bearing on a 750-hp. vertical cross-compound engine that had been in service over ten years on a 24-hour day schedule. The oilers on the different shifts began to report this bearing running very warm, and despite two copious streams of oil from a gravity system, the temperature kept increasing until one day the engine had to be taken out of service.

The bearing shells were removed and found to be in the best of condition, the oilways clean and sufficient and the shaft smooth and bright. The engineer insisted that the shaft was too smooth, and that there were no hollows to carry the oil around, and despite the remonstrances of others of the crew he proceeded to draw-file the shaft, using a new 12-in. bastard file with very light pressure.

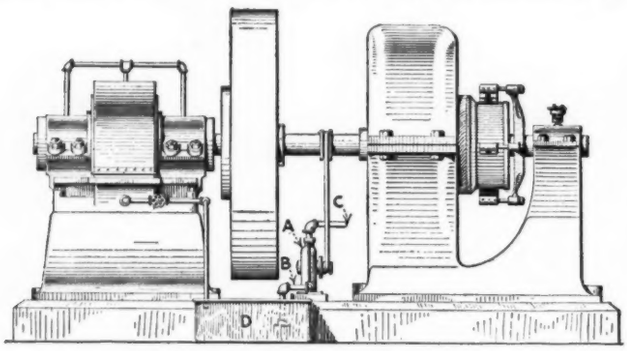
When he had finished, the shaft was covered with light scratches running lengthwise of the bearing. After carefully cleaning off the shaft, the shells were replaced and the bearing made up. The engine was started and full load immediately applied. This bearing was then the coolest one on the engine and never gave any trouble in the next three years it ran. The engine was then scrapped to make room for more modern equipment. ADOLPH QUADT.

Perth Amboy, N. J.

Waste-Oil Pump on Engine

Oil from the bearing and moving parts of a side-crank engine was collected in an oil well on the engine bed. There was no convenient way of removing the oil to the filter, so the engineer rigged up a pump to do the trick.

This was a small 1¼-in. centrifugal pump *A*, belt-driven from the crankshaft. The suction pipe *B* was ⅜-in. and the discharge pipe *C*, ¼-in. The suction pipe



OIL PUMP FOR ENGINE DRIPS

ran to the oil well *D*, and the discharge was piped to an oil filter, not shown, which was elevated several feet above the engine so that the filtered oil could be delivered by gravity to the engine oil cups and bearings. The illustration shows about how the apparatus was piped. The pump was supported by an angle iron that was secured by capscrews to the engine bed.

Philadelphia, Pa. L. R. CAMPBELL.

Burning Powdered Coal

I have read with considerable interest the comments made by J. B. Crane on the article, "Burning Powdered Coal," by F. R. Low, which appear on page 902 in the May 31 issue.

It seems to me that some of Mr. Crane's statements might easily be misunderstood by those not familiar at first hand with the operation of boilers burning pulverized coal. His remark, that the early experiments with powdered coal under boilers failed because all the air for combustion was supplied at the burner and small combustion chambers were used, is not exactly correct. The practice of supplying all or nearly all of the air for combustion at the burner is a good one and is based on the fact that a rapid mixture is more readily obtained under that condition whereby a short, quick flame can be secured and complete combustion accomplished within the furnace. The trouble that was experienced was due to the use of furnaces that were not designed for burning pulverized coal at the ratings attempted.

Mr. Crane states that the maximum efficiency possible is approximately 76 per cent and suggests that if the higher open-hearth temperatures could be maintained in the furnace, the efficiency would rise to from 83 to 85 per cent. It is of interest in this connection to observe that these latter efficiencies have been obtained continuously and have been exceeded without approaching any such destructive temperatures as he mentions, at the Lakeside plant at Milwaukee, a fact which would point to some error in his calculations.

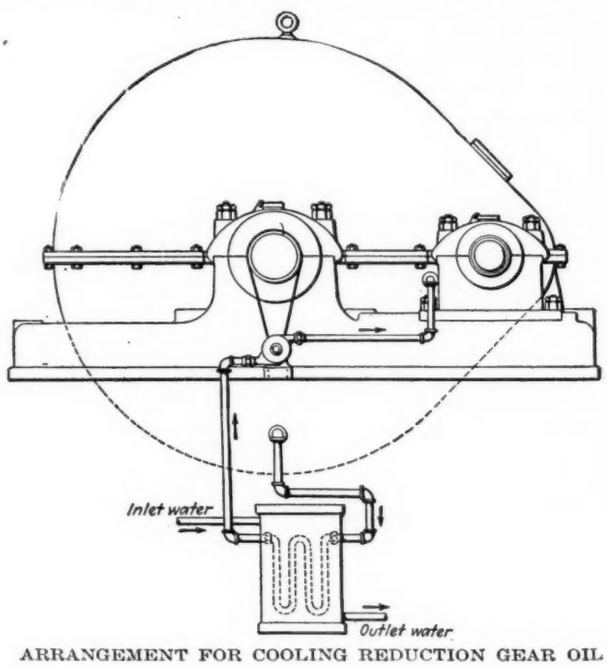
Pulverized coal is being burned efficiently in a number of installations without undue wear of the refractories and with very good results, the continuous efficiencies approaching closely the maximum obtainable. While the development of an especially high-grade and refractory furnace lining would be of value in the burning of pulverized coal, it is not more essential than it is in burning fuel in other form. It should be borne in mind that the most important factor in operation with pulverized fuel is the proper design of the furnace for the maximum normal rating.

H. G. BARNHURST, Advisory Engineer,
Allentown, Pa. Fuller Engineering Company.

Cooling Reduction-Gear Lubricating Oil

In one instance a set of reduction gears, consisting of a herringbone gear and pinion, worked under such conditions that the lubricating oil supplied to them reached a temperature of 148 deg. The engineer, desiring to reduce this temperature in order to obtain better lubrication at a lower temperature, rigged up the oil cooler shown in the illustration.

A piece of 6-in. pipe about two feet long and capped at both ends was procured. The pump that was originally used with the gears was repiped so that the suction pipe connected to an outlet of the cooling coil, which was placed in the 6-in. pipe. The discharge pipe from the pump connected as usual with the gear casing. The other outlet of the cooling pipes connected to the original suction connection of the pump to the gear casing. With the new arrangement the oil flowed from the gear case through the cooling coil to the pump-



ARRANGEMENT FOR COOLING REDUCTION GEAR OIL

suction inlet. The cooling coil consisted of four lengths of brass pipe connected by U-bend fittings.

At the top and bottom of the 6-in. pipe side water connections were made, the water and oil flowing on the counter-current principle. That is, the water entered the 6-in. pipe at the top and discharged on the other side at the bottom, while the oil discharged at the side where the cooling waters entered. With this arrangement the temperature of the oil was reduced from 148 to 106 deg., a drop of 42 degrees. P. A. SIMMONS.

Philadelphia, Pa.

Overheating of Iron Conduit Containing Three-Phase Conductors

The following accident happened recently in our plant: A bank of three 150-kw. 2,300- to 480-volt 60-cycle three-phase transformers connected to the city system served as an auxiliary supply under continuous operation. The transformers were delta-connected, as shown in Fig. 1, the secondary leads being led separately through two 3½-in. iron conduits, each about 19 ft. long, and the delta-connection was made at the terminals of the oil switch. The conduits were bonded together at each end by heavy iron clamps used for supporting them from the brickwork of the building. About a month after some structural alterations to the plant, one of the transformers burned out, and upon investigating, the connection illustrated in Fig. 1 was discovered. It appeared to be on a totally wrong principle, for the iron conduit acted as the short-circuited secondary of a single-turn transformer. The magnitude of the current produced was shown by removing one of the supporting clamps and substituting a No. 18 iron wire; the wire was heated to a visible red by the induced current. The cables were pulled out as soon as possible and their insulation, braid over rubber, was found to be completely ruined, so great had been the heating of the conduit.

Does it seem possible that the increased inductance of the circuit due to arrangement of the wiring so reduced the power factor of the transformer that the wattless current caused excessive heating and ultimately a breakdown in the primary winding? There was no unusual disturbance on the factory lines at the time of the accident, to which it could be ascribed.

The situation was remedied by reconnecting the secondary cables, so as to make the delta-connection at the transformers, as shown in Fig. 2. Each duct then carried the equivalent of a three-phase cable, the two being in parallel. No signs of current can now be detected in the conduits and we have had no further trouble.

H. D. FISHER.

New Haven, Conn.

[It is hardly probable that the arrangement of the wiring shown in Fig. 1 had anything to do with the breakdown in the transformer. The inductance of the secondary circuit was probably only slightly increased by the connection in question, owing to the fact that the conduits were short-circuited. The connections were equivalent to a series or current transformer, the primary of which was the transformer leads and the secondary the iron conduits that also served as an iron core. The short-circuit current circulating in the latter opposed the primary current in its tendency to produce flux, and the actual amount of flux set up in the iron was probably relatively small when the two conduits were clamped together. This was no longer true, however, when one of the clamps that short-circuited the conduits had been removed. The secondary of the equivalent series transformer was then opened and all the primary current became effective in setting up flux in the iron conduit, and inducing voltage between the two ends of the conduit. The inductance of the primary circuit in this case was very much increased over the former. The breakdown of the transformer was probably a mere coincidence, and in no way connected with the arrangement of secondary wiring.

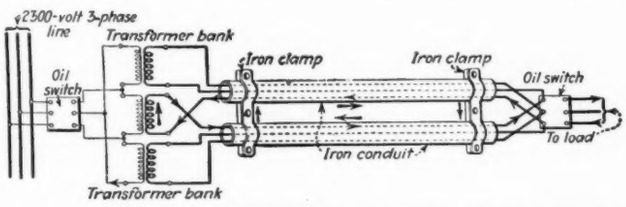


FIG. 1. FAULTY WIRING WITH DELTA CONNECTION AT OIL SWITCH TERMINALS

The arrowheads indicate circuit acting as primary of a series transformer, the secondary of which is the iron conduit. The arrows indicate the current flow in the iron conduit and clamps.

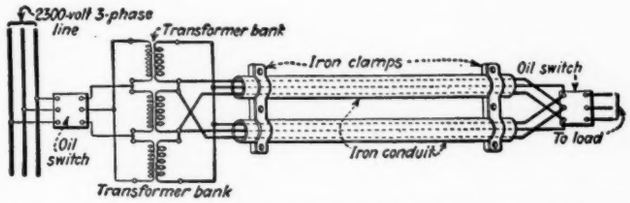


FIG. 2. CORRECTED WIRING, WITH DELTA CONNECTION AT TRANSFORMER TERMINALS

Each conduit contains a complete three-phase circuit, and the total magnetomotive force of the three conductors is zero. There is therefore no tendency to produce flux in the conduit.

The foregoing trouble is of real interest, however, as an illustration of a danger that is often considered negligible, that of heating from high currents or flux densities induced in iron conduits containing single conductors carrying alternating current, or unbalanced combinations of conductors. Iron conduit can be used for several alternating-current conductors only when the resultant magnetomotive force of all the conductors is zero, as with three conductors of a three-phase or two-phase circuit. It can never be used for a single conductor carrying alternating current. With the connections shown in Fig. 1, each conduit contains two leads of one transformer that neutralize each other, and one lead of transformer No. 2, the magnetomotive force of which is not neutralized, and sets up flux in the iron. This flux in turn induces electromotive force in the iron itself, which causes current to flow along the conduit and through the iron clamps, as shown by arrows in Fig. 1. The arrowheads indicate the primary circuit of the equivalent series transformer.—Editor.]

Adjusting Back-Pressure Valve

The device for adjusting a back-pressure valve from a distance, described by A. J. Dixon in the May 17 issue of *Power* is ingenious, but it has one fault; the valve can be overloaded or possibly obstructed in its action. Also, the arrangement is applicable only to situations where the lower lever can be placed vertically beneath the lever on the valve.

I have in mind a multiported type of back-pressure valve in which the tension of all the springs is adjusted simultaneously by moving a pressure plate up or down by means of a vertical threaded spindle. Overloading is prevented by a lug on the bottom of the pressure plate, which strikes the valve deck before the springs are fully compressed; a fixed, predetermined back pressure, therefore, cannot be exceeded. When the pressure plate is raised to its highest position, the valves are lifted from their seats, giving free exhaust to the atmosphere.

GEORGE H. GIBSON.

New York City.

Why Belts Run Up

In the May 10 issue of *Power* Harry S. Curtis asked why belts "run up" in view of the fact that "mechanical action takes place in the line of least resistance." The question raised by Mr. Curtis is one that arouses much speculation among power-plant men and gives rise to many quaint and complicated explanations, which are often more interesting than satisfactory. The following explanation appears to furnish satisfactory evidence that a belt should "run to the high side" (in the case of conical or crowned pulleys) and, I believe, is generally accepted as the cause of this phenomenon.

In Fig. 1 is presented an exaggerated view of the condition existing when a belt is on one side of a crowned pulley. The belt is deflected toward the low side on account of its tension. If the cross-section of the pulley is regarded as an inclined plane, it is apparent at once that the belt tension has a component tending to cause the belt to slide down the surface *ed* and take the position indicated by the solid lines. With the small tapers used, however, the friction between the leather and metal is more than sufficient to keep the belt from sliding over the edge of the pulley.

If the near face of the pulley is assumed to be running up, it is evident that point *a* tends to move to the position *b*. Every point in the width of the belt has the same tendency, so the belt eventually moves to the position indicated by the dotted line *bc*. In this way the belt continually climbs to a greater diameter until part of it is on the right side of the crown. The part on the right side tends to curve the belt toward the right, just as it curved toward the left in the first place. When the center line of the belt is on the center of the crown, a balance is reached and the belt runs straight.

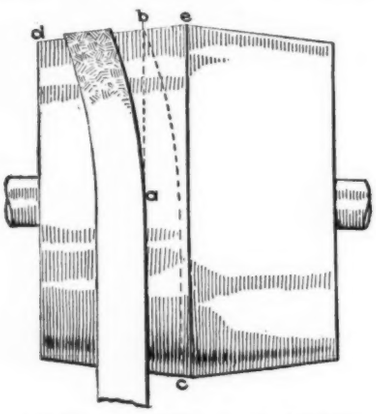


FIG. 1. BELT "CLIMBING" A CROWNED PULLEY

If for any reason the belt is displaced a little to the right or left, it becomes curved in that direction, which causes it to climb back to the center position.

Although the belt rides to the greatest diameter in the case of conical or crowned pulleys with parallel shafts, it should not be assumed that a belt will always go to the "high point." The opposite effect is usually observed in the case of cylindrical pulleys with shafts at an angle.

This fits in with the well-known fact that if a belt is not fed squarely onto a cylindrical pulley, it will work over toward the side from which it is being fed. Refering to Fig. 2, it is evident that if the mechanism is to operate in accordance with the foregoing law, the point *b* must leave pulley *B* in the plane *x'x* perpendicular to the shaft of pulley *A*. The point *a* which is supposed to be on the farther side of the pulley must, if the law is to be followed, leave pulley *A* in the plane *y'y* perpendicular to the shaft of pulley *B*. At first this latter condition is satisfied, but as soon as the center line of the near side of the belt starts to move to the line *x'x* point *a* can no longer feed squarely onto pulley *B*. The

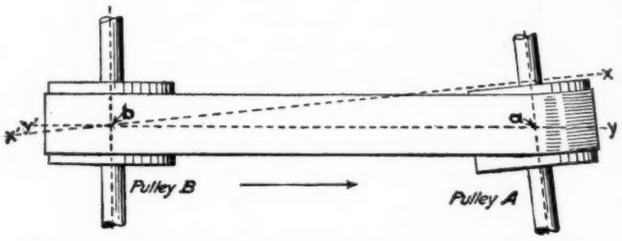


FIG. 2. BELT GOES TO "LOW" SIDE IF SHAFTS ARE OUT OF LINE

result of this arrangement is that the belt works along both pulleys toward the side where the axes are nearer together. If the angle between the shafts is small and crowned pulleys are installed, this tendency can be overcome within certain limits. PAUL F. CHRISTOPHER.

Lynn, Mass.

[This problem was discussed in the July 12 issue by Rudolph Wildermann and Ralph P. Emerson. All agree that the belt will run to the "high side" in the case of crowned or conical pulleys. However, in the case of straight pulleys with shafts at an angle, Mr. Emerson disagrees with the others and contends that the belt will run off the "high side". He reaches this conclusion by comparing the action of the belt with that of wire being wound on a mandrel in a lathe. The comparison is used in a way where it would only seem to be valid if wire were fed on spirally, not by *moving* the hand but by *turning* it. The latter would hardly be expected to force the wire over to any appreciable extent if it were under tension. Other discussions, some of considerable interest, were sent in by the following: M. A. Anderson, Pittsburgh, Pa.; J. A. Benefiel, Anderson, Ind.; J. S. Jacobs, Springfield, Vt.; L. Johnson, Exeter, N. H.; Herman Miller, Brooklyn, N. Y.; Patrick Molloy, New York City; R. Manly Orr, Vancouver, B. C.; C. O. Sandstrom, Kansas City, Mo.; W. R. Spiller, Philadelphia, Pa.; Vernon O. Wheeler, Morgantown, W. Va.; H. K. Wilson, New Bedford, Mass.—Editor.]

Made Wooden Tank Tight

Some wooden sprinkler tanks on the roof gave considerable trouble from leakage in the winter. These leaks formed icicles which would fall off and punch holes in the roof. After various schemes had been tried without avail, we adopted the following, which was successful.

The bottom and also the sides of the tank were thoroughly tarred inside. Then around the inside edge, where the flat part met the curved part, strips of cloth were tamped in. Roofing tar was poured on top of these, and a double layer of roofing felt was laid on the bottom (inside) and flashed up the sides to a distance of about four feet on the cylindrical part. This roofing felt was then tarred. This procedure made the tanks quite tight. N. H. PUGH, JR.

Cincinnati, Ohio.

The Heating Plant as a Source of Power

Comments of R. DeWolf, of Rochester, in the issue of March 29, on my article of Nov. 30, 1920, are somewhat critical and biased. In no way is the main fact disproved "that a constant power load of 90 per cent of the heating horsepower required in zero weather is available from the heating fuel every hour the heating system is operated at practically no additional expense for steam generation." Naturally, and it is so stated, if the recovered current cannot be utilized in sufficient quantity, the combined operation will not pay. The difference of opinion seems to be in the number of hours during which the heating system operates and the power that may be utilized.

In the article of Nov. 30 the power recovery estimated would warrant the low rate of one cent per unit, but that assumed by Mr. DeWolf would involve a much higher rate. He utilizes, partly, assumptions of the author as to demand and flat rate for current and deliberately changes the consumption and period of operation without a corresponding change in the flat rate for purchased current.

Relative to the types of fixtures used on steam and water systems in common, his statement is confused with the amount of radiation. The only type of radiator not common to both is the column steam radiator without a top connection, which cannot be used with water. The amount of radiation is determined solely by the temperatures outside, in the room and of the medium, whether steam or water is used. This is illustrated in

TABLE I. TEMPERATURE OF HEATING MEDIUM VS. RADIATING SURFACE

Schedule	Type System	Av. Temp. System Deg. F.	Drop, Deg. F.	Heating Surface, Sq.Ft.	Size Main, In.
C	Low-pressure steam overhead and below	227	..	5,310	5
A	Gravity hot-water piping below	210	30	5,465	6
A′	Forced hot water	210	20	5,725	3
B	Gravity hot water	170	25	8,244	8

Table I, which is taken from the author's section of the Hool & Johnson Handbook on General Building Construction, page 1128, Vol. 2. The same building was used as a problem and the heating plant designed with various temperatures of steam and hot water. The results speak for themselves.

From actual plant records and Edison bills of a number of plants in Detroit, month after month, 14 hours a day was about the period the demand load would operate for the total monthly consumption, or 60 per cent of the maximum period by the maximum demand. Records from four different plants are given in Table

TABLE II. AVERAGE HOURS PER DAY ON BASIS OF MAXIMUM DEMAND

No. Plant	Period Months	Average Demand, Kw.	Number Work Days	Kw.-Hr. for Period	Average Hours for Maximum Demand
1	10	882	26	325,844	14.2
2	6	2,381	25.5	844,180	13.9
3	12	4,300	306	17,860,800	14.4
4	12	712	306	3,336,253	15.3
Average					14.45

II. These plants operate 24 hours a day. The article of March 29 uses the shop period of 8 hours with 65 per cent of the demand, which is assumed as the power load recovered from the heating fuel.

The first operation will be to determine the rate for current under the operating conditions assumed by Mr. DeWolff and which was figured at one cent per kilowatt-hour. This low rate is obtained here in Detroit when the customer purchases his own transformers. The rate is made up as follows: First 200 units demand, $3 each, all thereafter $1.25 per kw.; first 100,000 units consumption, $0.008, all thereafter $0.007. The sum of these is taken and 5 per cent deducted for cash. With a demand of 500 kw. and 774,000 kw.-hr. consumption for 8 months, or 96,750 kw.-hr. per month, the flat rate will be 1.72c. instead of 1c., and the gross saving $13,312.80 instead of $7,740.

Mr. DeWolf assumes that operation at high pressure and superheaters will cost $10 per horsepower, and that with spare boilers of a total equivalent to 13,330 sq.ft. of heating surface will be required. With a maximum load less than 6,000 sq.ft. of boiler surface, 5 per cent of the time, when the outside temperature is below 10 deg., why is 13,330 sq.ft. of boiler-heating surface necessary? Correcting the rate for current, reducing the boiler power and leaving the other items the same, gives the following:

Gross revenue at 1.72c. per kw.-hr.	$13,313
Oil and coal as before	1,119
Net revenue	$12,194
Superheater and boilers, 6,000 sq.ft. @ $1	6,000
2—500-kw. turbines and condensers @ $50	50,000
Investment	$56,000

$$\frac{12,194}{56,000} = 21.77 \text{ per cent instead of } 10.47 \text{ per cent}$$

In the second problem, with 2,000 kw. in generating equipment and 1,000 kw., or double the demand, there are only 850,000 kw.-hr. In the first example, with 500 kw. demand, there are 774,000 kw.-hr. The second example will be corrected to give 845-kw. demand and 850,00 kw.-hr. consumption for 8 months, or 106,250 kw.-hr. per month. In generating equipment 1,500 kw. will be used instead of 2,000 kw. and $50 per kw. will be the price delivered and erected. The author obtained this price from a reputable manufacturer a few days ago, and it includes condensers and auxiliaries. From the same base rate as before, the current rate per kilowatt-hour reduces to 2.013c. and the gross saving per season amounts to 850,000 × $0.02013 = $17,110.50. Deducting the $1,119 given by Mr. De Wolf leaves a net income of $15,991.50, or say $16,000.

The investment is as follows:

Boilers, 10,000 sq.ft., and superheaters @ $1	$10,000
Generating units and condensers, 1,500 kw. @ $50	75,000
Total	$85,000

Then $16,000 ÷ $85,000 = 18.8 per cent return on the investment instead of 5.5 per cent.

Both of these estimates are incorrect, as at a glance the current consumption for the equipment installed is ridiculously low, and in any case, if these are facts, the plant would be one to let alone on the combined heating and power plan.

The probable saving on a plant with 500 kw. load from the heating will be figured as follows: Heating season, 210 working days; power, full demand, 900 kw. for 14 hours, with 500 kw. from the heating system; one machine installed and the remainder of the power purchased. The total kilowatt-hours for 8 months will be 210 × 14 × 900 = 2,646,000. If 450 kw. were purchased, this would come in the 8-hour period of shop operating, the remainder being distributed over the rest of the 24 hours at lighter loads. The purchased power would then amount to 450 × 8 × 210 = 756,000 kw.-hr., and the actual power recovered from the heating fuel would be 2,646,000 — 756,000 = 1,890,000 kilowatt-hours.

With all current purchased, 2,646,000 kw.-hr. in 8 months, or 330,750 kw.-hr. a month, at the rate previously given, the monthly cost would be $3,739, or 1.13c. per kw.-hr., and the cost for the season of 8 months, $29,912.

If 450 kw. were purchased, 756,000 kw.-hr. during the season or 94,500 kw.-hr. a month, the monthly bill would be $1,585.48, and the rate, 1.68c. per kilowatt-hour.

The cost of using one machine with breakdown service and a 450-kw. demand purchased would be:

Purchased current, 756,000 kw.-hr. @ 1.68c	$12,700.80
Additional coal as before	1,041.42
Oil as before, 1,890,000 kw.-hr. @ 0.01c	189.00
Operating expense	$13,931.22

The investment will be:

Boilers, 6,000 sq.ft. and superheaters @ $1	$6,000
Generating unit and condenser, 500 kw. @ $50	25,000
Total investment	$31,000

The cost when all current is purchased is $29,912, as previously given, so that the saving would be $29,912 — $13,931 = $15,981. The return on the investment will then be $15,981 ÷ $31,000 = 51.6 per cent.

With regard to the temperature differences at the limits of operating on the condenser, the 11.5 deg. has been realized by the author in practice. For the other limit, if the water is changed from 100 to 90 deg., it will be nearer correct. The idea intended to be conveyed was that heating at this period was the same as straight power generation with no expense. This limit will change with the design of the plant, whether the normal vacuum is 26, 27 or 28 in. It in no way affects the problem or facts intended to be demonstrated.

TABLE III. STEAM RATES OF 500-KW. TURBINE
(150 Lb. Pressure, No Superheat)

Vac., In.	Rates at 250 Kw., Lb. per Kw.-Hr.	Rates at 400 Kw., Lb. per Kw.-Hr.	Rates at 500 Kw., Lb. per Kw.-Hr.
28	22.5	20.5	20
27	24	22	21.5
26	25.5	23.5	22.5
Atmosphere	47	43.0	41.5
4 lb.	50	45.6	44

In the following, the points made by Mr. DeWolf at the end of his contribution are taken up in sequence:

1 and 2. If a cast-iron boiler-heating plant were under consideration, Mr. DeWolf's point might hold; but all plants here have a full force of engineers, firemen, etc., to operate high-pressure boiler plants, and generally some power is developed, even where a large part of the current is purchased.

3. As a matter of fact the combined system, with careful regulation of the vacuum at the power house, will actually reduce the total heat required over the constant-pressure steam system and open windows.

4. Reference to Table III will throw some light on this question. Mr. DeWolf is assuming too much and his involved method of calculating the steam rate is unnecessary and inaccurate.

5. The economy of continuous operation on large plants is unquestioned and has been proved time and again by weighing the fuel under both methods, so there need be no argument about the time of starting. Within the limits of the machine any power load can be carried at any condition of heating load and all changes effected without opening the relief valve or stopping the generating unit. It is being done at present so that the lack of synchronization does not exist.

6. The cost of pumping is the same for nearly all heating systems, although it may not appear so on the surface. There are the vacuum pumps on the steam system and feed pumps; motor-driven centrifugal pumps are used for the hot-water system. It is an item, but would not appreciably affect the results.

The cost of changes in the heating system were not included, as the hot-water system, properly regulated, will more than pay for this in the total decrease in fuel over the steam system. Where the system is well designed for steam, the expense of the change is not very great. All turbo-generator and condenser prices were taken at $50 per kw., including both pieces of apparatus, and they can now be purchased for this amount.

There are, unquestionably, plants that it will not pay to operate in this manner, but there are others that will pay a handsome return on the investment when operated under proper conditions.

IRA N. EVANS.

Detroit, Mich.

Waste of Steam in Paper Mills

Some paper mills are inefficient in their operations and in the use of steam. It has been considered by some mill operators that it is more economical to dry paper with 10 or 20 lb. back pressure on the engines than with live steam.

In a mill having Corliss engines for driving the beaters and jordans in connection with the stock and water pumps for supplying the raw stock and water to the paper machines, variable speed slide-valve engines carry the load of the paper machines. These engines were required to work against a back pressure of 10 to 25 lb. and to carry the load of the mill, and the fuel consumption was 2,500 to 3,000 lb. of coal per ton of paper produced. The opinion of the operators was that they could not carry out the production of the mill under any other condition to produce the normal output, which was 90 tons in 24 hours, and they stoutly maintained their position.

It was necessary to shut down to make changes which could not be carried out while operating. As the paper machines were in good condition, there was nothing done that would help in the saving of fuel or to raise the production. On starting up, the operators called for 10 lb. back pressure to dry the paper, in addition to 25 lb. live-steam pressure, and as it was impossible to explain a better and more efficient way to reduce the steam consumption, it was necessary to use strategy. Therefore the gages on the exhaust headers in the machine room were set with the pointers bent to bear against the dial at 11 lb. and the back pressure on the engines reduced to 2 lb. The pressure on the live-steam driers was increased from 5 to 10 lb. as the operators wished, and as the gage pointer was stuck at the 11-lb. graduation, they were of the opinion that there was 11 lb. of back pressure on the driers using exhaust steam. This was carried on for a week, at the end of which time the coal consumption and paper output was checked, with a showing of 1,900 lb. of coal per ton of paper.

Such conditions as these are taking place in plants other than paper mills, and with a little forethought and figuring to try to get away from ideas that someone had years ago, there would be a great deal less fuel wasted and a higher production.

North Tonawanda, N. Y. CHARLES J. MILLER.

INQUIRIES OF GENERAL INTEREST

Corrosive Grooving of Boilers—What causes corrosion of a boiler to take the form of grooving? R. G.

Cracks in the surface of the material caused by movements from changes of pressure and temperature rapidly become deeper and broader from corrosion. The movements loosen particles of rust as fast as they are formed and expose fresh surfaces for formation of more rust and thus hasten the corrosion in formation of grooves. Hence grooving is most likely to occur near lap joints where small cracks are formed from bending action of the material or in corners of flanges, as in the head of a drum or boiler near its junction with the cylindrical port of the shell.

Double-Arm Bourdon-Spring Pressure Gages—Why are Bourdon springs in some pressure gages connected at the middle of their length instead of at one end of the tube? W. L.

The arrangement is adopted to reduce the amount of vibration of the gage hand due to jarring the gage by use of two short-arm springs in place of a single long spring. By compounding the motions of the shorter arms, the same sensitiveness of pressure measurements is obtained as from the use of a long tube with the pressure connected at one end. The double-arm form of gage tube, with each section curved less than a semicircle, is also advantageous for use in gages exposed to temperatures below freezing, as the tubes can be more readily drained of water than longer single tubes.

Wristplate Must Swing Equally Each Side of Center—In setting the valves of a Corliss engine, the wristplate was placed central, valve rods were adjusted to give each steam valve ¼-in. lap, and exhaust valves placed line on line. After hooking up the wristplate, with the engine on the head end center, the eccentric was set on the shaft to give the steam valve $\frac{1}{16}$ in. lead, but there was less than $\frac{1}{32}$ in. lead on the crank end, and upon starting up the engine pounded badly. How should the valve setting be corrected? J. J. M.

There was less lead on the crank end and also late release and too little compression on the head end, because the eccentric rod and reach rod to the wristplate were not long enough to carry the wristplate as far to one side as the other of its central position. In setting the valves, first adjust the length of the eccentric rod so the rocker will swing as much to one side as the other of a plumbline, and adjust the length of the wristplate reach rod so the central mark on the wristplate travels as far to one side as to the other side of the central mark on the stud. Then, when the valve rods are adjusted with the wristplate in central position to give equal laps to the steam valves, setting the eccentric to give $\frac{1}{16}$ in. lead on one end should give the same lead on the other end; and if the exhaust valve rods had been adjusted to place the exhaust valves line-on-line for the central position, release and compression should be the same for both ends of the cylinder.

If the different steps of the valve setting have been performed with care, there may be some inequalities of lead, release or compression due to angularity of the valve gear, but these may be corrected by readjusting the lengths of the valve rods.

Reconnecting a Three-Phase Transformer Bank—A bank of three delta-delta connected single-phase 25-cycle transformers with 2-coil secondary windings has just been installed to step down three-phase power from 11,500 to 440 volts. The two secondary coils are connected in series, as shown in Fig. 1, the leads at the middle point being brought out to give 220 volts. Owing to transmission considerations, however, the primary voltage has been increased to 13,000 volts, and the corresponding secondary voltage of 500 is somewhat too high for 440-volt motors. Is there any way of correcting this, such as introducing a choke coil in series with the motor circuits? One terminal of the secondary delta has been grounded, and this gives a voltage of 500 between the other two leads and the ground, which is somewhat dangerous. Would it not be better to ground the middle point of one secondary, as shown in dotted lines in Fig 1? M. P.

Any scheme for reducing the secondary voltage by the introduction of reactance in series with the load would be useless, as it would be effective only at relatively heavy loads, and, at light loads, the motors would be practically

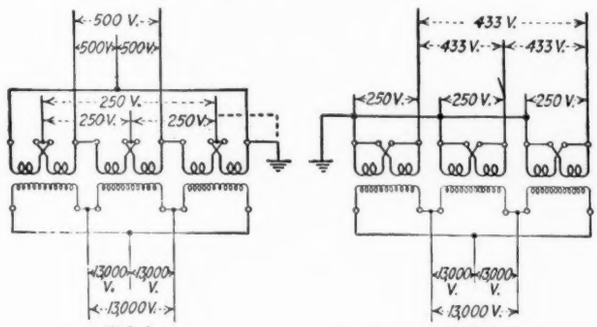


FIG. 1. EXISTING CONNECTIONS, GIVING TOO HIGH SECONDARY VOLTAGE
FIG. 2. PROPOSED CONNECTIONS

under 500 volts. The best method is to reconnect the two coils of each secondary in parallel, and connect the three secondaries star instead of delta, as shown in Fig. 2. This will give a voltage of 250 volts between phase wire and neutral, and $250 \times \sqrt{3}$, or about 433 volts between phases. This voltage will be better for 440-volt motors than for 500. These connections will be particularly satisfactory from the point of view of the grounding of the secondary circuit. Grounding the neutral of the secondary star will give a potential of 250 volts between any one of the three lines and the ground, as against 500 volts between two of the lines and the ground in the present system. Furthermore, the suggested method of grounding the middle point of one leg of the delta, as indicated in dotted lines in Fig. 1, would give a voltage of 250 from two of the lines to the ground, but 433 volts from the third to the ground.

[Correspondents sending us inquiries should sign their communications with full names and post office addresses. This is necessary to guarantee the good faith of the communications and for the inquiries to receive attention.—Editor.]

Recording Ashpit Loss from Chain-Grate Stokers*

By E. G. Bailey†

There has been much guesswork but very little knowledge regarding ashpit loss. The analysis of a daily average sample of ash from the entire plant does not place the responsibility on definite boilers and firemen. A simple device is needed that will give reliable and continuous indication of the loss due to combustible in the ashes. This paper describes such a device, recently developed, and gives data and conclusions from preliminary tests made in connection with chain-grate stokers.

The apparatus consists fundamentally of a pyrometer of the gas-filled type so placed that its temperature depends on the amount of heat radiated from the mass of ash and combustible just before its discharge from the end of the grate. Fig. 1 shows the general arrangement. The bulb, the temperature of which is to be recorded, is of steel and is filled with nitrogen. It is obvious that the bulb should extend completely across the grate at some point near the discharge. Connection is made by capillary tubing to a recording pressure gage of the mercury-filled U-tube type. Fig. 2 shows two locations, *a* and *b*, which were used in these tests and of which the latter, at position No. 2, gave more consistent results. Fig. 2 *a* corresponds with Fig. 1

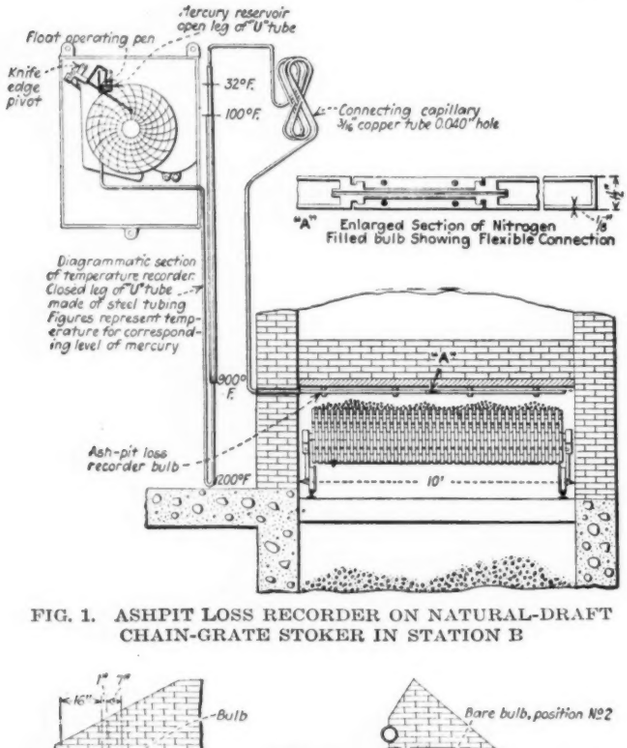

Mercury reservoir open leg of U tube
Float operating pen
Knife edge pivot
32°F.
100°F.
Connecting capillary 3/16" copper tube 0.040" hole
"A" Enlarged Section of Nitrogen Filled bulb Showing Flexible Connection
Diagrammatic section of temperature recorder. Closed leg of U tube made of steel tubing. Figures represent temperature for corresponding level of mercury
900° F.
"A"
Ash-pit loss recorder bulb
200°F
10'

FIG. 1. ASHPIT LOSS RECORDER ON NATURAL-DRAFT CHAIN-GRATE STOKER IN STATION B

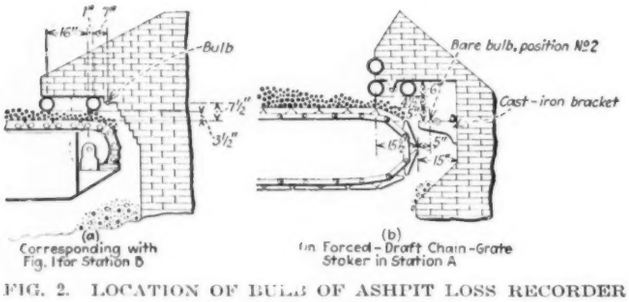


FIG. 2. LOCATION OF BULB OF ASHPIT LOSS RECORDER IN STATIONS A AND B

By plotting the results of a number of tests it was found that for a given boiler and a given arrangement of the bulb the loss of heat due to combustible in the ash increases in direct proportion to the increase in bulb temperature. This relation is practically independent of the load or the ash content of the coal, which makes possible, for any given installation, the calibration of the recorder to indicate directly the percentage of heat lost in the ashes.

Arrangements were made to record continuously on a single chart, as shown in Fig. 3, the temperature of the bulb and the flue-gas temperature together with the flow of air and steam. This permitted a comparison of the excess-air loss with the grate loss. As far as other conditions will

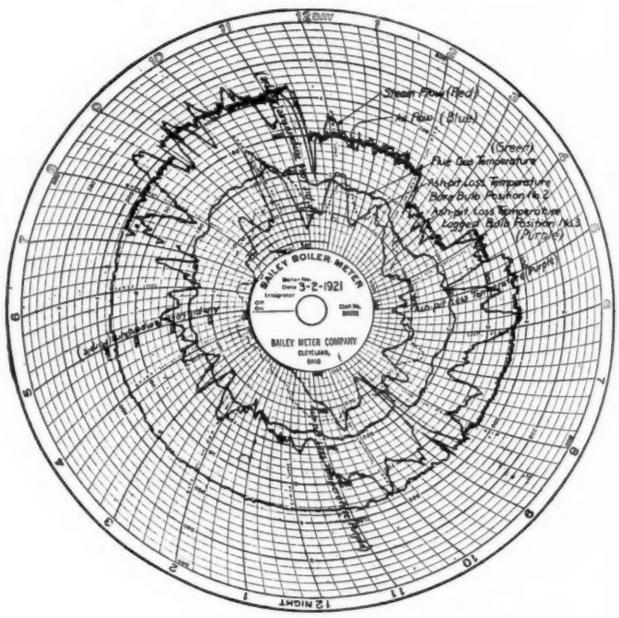


FIG. 3. CHART FROM ASHPIT LOSS RECORDER IN STATION A

permit, the stoker should be operated so that the sum of these two losses and the loss due to unburned gas is a minimum. In these tests it was found that as the load was increased there was a decrease in the excess-air loss together with an increase in the ashpit loss. The sum of these reached its minimum before unburned gas began to appear. Without the knowledge of the ashpit loss erroneous conclusions might be drawn from a study of flue-gas losses.

Conclusions

a. The temperature of a bulb properly located near the rear of a chain-grate stoker responds definitely to changes in the amount of combustible going to the ashpit.

b. The temperature varies in direct proportion to the percentage of heat lost to the ashpit when the bulb is properly located.

c. For a given installation this relation is practically independent of grate speed, rate of combustion and percentage of ash in coal.

d. A continuous record of the ashpit loss enables the fireman to control this important factor effectively.

e. From suitable records there can be plotted characteristic performance curves for stokers showing the separate and combined losses due to unburned combustible, unburned gases and excess air.

f. These curves can be used to compare different types of stokers and kinds of coal and to check the work of the fireman.

That the British coal miner is lying down on his job is indicated by some striking figures printed in *The Engineer, London*. The number of persons employed in the coal mining industry in 1913 is given as 1,127,890 and their output as 287,411,869 tons, whereas the number employed in 1920 was 1,248,224 and their output was but 229,503,435 tons. This means that in seven years the yearly output per man has dropped from 255 to 184 tons.

*Abstract of paper presented in May at Chicago, Ill., before the American Society of Mechanical Engineers.

†President of Bailey Meter Co., Cleveland, Ohio.

Washington News

Power Commission Completes First Year's Work—Coal Bill Not To Be Pressed Now—Europe Interested in Water Power—Tariff on Oil Discussed

By Paul Wooton
Washington Correspondent

The first year's operations of the Federal Power Commission under the Federal Water Power Act of June 10, 1920, have given a clear indication of the need for the legislation and the extent to which power development had been delayed by lack of satisfactory Federal laws. Up to June 30, 1921, there had been filed with the commission 229 applications aggregating 14,675,000 hp. and affecting 33 states, the District of Columbia and Alaska. This amount is 75 per cent greater than the entire water-power development of the United States today. It is 50 per cent greater than the combined water-power resources of Norway and Sweden and considerably in excess of the combined resources of France and Italy. It is five times greater than the aggregate of all applications filed with the Federal Government in the preceding 15 years. The projects applied for vary in size from less than 100 horsepower up to the three million horsepower scheme of the Southern California Edison Co. on Colorado River.

Commission Badly Hampered

In creating the commission and putting upon it duties many times greater than had been exercised previously by any of the Executive Departments in connection with water-power development, Congress gave the commission no personnel to perform its work other than its executive secretary and engineer officer. In order to function at all, it has been necessary for the commission to borrow from the several departments personnel for its Washington office. Even the limited appropriations made by Congress for the work of the commission are being returned to the Treasury unused because Congress, after making these appropriations, failed to grant the legislative authority to use them.

Although the commission has been obliged to work under serious handicap, it has nevertheless accomplished many things in the first year of its operations. The first license was issued on March 1 to the Niagara Falls Power Co. Between that date and July 1 final action has been taken on 47 applications; 13 preliminary permits have been issued, involving 1,075,000 hp; and 15 licenses, involving 757,000 hp. primary and 460,000 hp. secondary, or a total of 1,217,000 hp., making an aggregate of 28 projects, involving 2,292,000 hp., or as much as was issued by all of the Executive Departments during the 10 years preceding the passage of the Federal Water Power Act. There were also pending on June 30 for final action at the next meeting of the Commission 16 applications, involving 190,000 horsepower.

Projects involving hundreds of thousands of horsepower and tens of millions of dollars are now being constructed under licenses issued by the commission. The chief present defect in the act is its failure to provide adequate means for its expeditious administration.

Discussion of Coal Stabilization Bill Temporarily Dropped

Apparently, there is to be an intermission in legislative activities pertaining to coal. It is becoming increasingly evident that Senator Frelinghuysen played his hand well when he put up the seasonal rate bill to be shot at by the Senate. By withholding the coal stabilization bill, he now is able to keep the opponents of that measure on the qui vive continually. The bill is on the calendar with the ever-present possibility of its being called up unexpectedly, possibly when but few Senators are in the chamber. The more likely course, however, is that Senator Frelinghuysen will be content to allow the measure to remain on the calendar until sentiment in the Senate toward such legislation may undergo a change.

Were there to be a repetition this fall of the conditions that prevailed last year, it is recognized that there would be a chance to pass the bill. It is very generally admitted that had the Calder committee recommended legislation no more drastic than the Frelinghuysen bill, it would have succeeded in having it passed.

Information reaching Washington, however, both through Government and private sources, is to the effect that stocks are being well maintained. Current needs apparently are being abundantly cared for by the present rate of production, with little prospect that demand will increase at any time this fall or winter beyond the point where adequate distribution is assured. In that connection it may be stated that the hope for increased buying of coal is based at this time more largely on export than it is on increased activities on the part of American industries.

Water Power in Europe

Col. William Kelly, the chief engineer of the Federal Power Commission, has returned from a visit to England and France, where he conferred with government officials in charge of water-power matters. He found that officials in both France and England were watching with much interest the effect of the recent water-power act on American development. He pointed to the presence of the French commission in this country as an evidence of the interest France is taking in this subject.

While Colonel Kelly found that financial conditions in France are such as to preclude any great amount of hydroelectric development in that country at the present time, he was surprised to find that plans are practically in complete form for a number of important projects. Principal among them is the development on the Rhone, which is expected to furnish power for the Paris district and for the electrification of some railroads.

Colonel Kelly familiarized himself with the work being done by the British government on the problem of utilizing the tides for power purposes. Considerable work along the same line is being done by the French engineers.

The Proposed Oil Tariff

The proposed tariff of 35 cents a barrel on crude petroleum and 25 cents a barrel on fuel oil is causing a good deal of discussion in Washington. The independent oil companies, or at least some of them, charge that the opposition to the duty on oil is coming from the very large corporations, owing to their interest in Mexican petroleum. It is claimed that the duty is in the interest of 16,000 independent producers and refiners who are in danger of absorption by the more powerful companies. The large companies formerly controlled 80 per cent of the domestic production, it is declared by the independent companies, but this has been cut to 50 per cent in recent years, with the consuming public receiving the benefits of real competition. It is declared that imports of Mexican oil have permitted the building up of a surplus of approximately 25 per cent, which is pointed to as the cause of the demoralization of the industry, and that the cheaper foreign oil is being imported and delivered at a fraction of the cost of production in the United States.

American Engineers Honored

A recent cablegram from Europe telling of the presentation of the John Fritz Medal to two Europeans contains the interesting news that several other engineers have been notably honored by British engineering societies. The Americans were members of a deputation of American engineers that went to Europe but a short time ago for the purpose of presenting the John Fritz Medal and of promoting closer relations between American and British engineers. The deputation comprised some of the best-known engineers in this country and was headed by Ambrose Swasey.

According to the report, which was made public by Calvin W. Rice, secretary of the American Society of Mechanical Engineers, four members of the commission were elected to honorary membership in one or more English engineering societies.

Ambrose Swasey, sponsor of the Engineering Foundation and past president of the American Society of Mechanical Engineers, was made honorary member of the British Institution of Mechanical Engineers, the British Institution of Mining and Metallurgy and the British Institution of Mining Engineers. Charles F. Rand, chairman of the Executive Board of Engineering Foundation, who was very recently made honorary member of the British Iron and Steel Institute, was elected to honorary membership in the Institution of Mining and Metallurgy and in the Institution of Mining Engineers. Col. Arthur F. Dwight, of New York, and William Kelly, of Vulcan, Mich., also received honorary membership in the Institution of Mining Engineers.

In this connection it is interesting to note that Mr. Rand has become one of five honorary members of the Iron and Steel Institute, the others being the Prince of Wales, King Albert of Belgium, and Dr. Richard Akerman and Baron Gustaf Tamm, of Stockholm.

The cablegram indicated that the American engineers were being received with marked courtesy in both England and France, and confidence was expressed that the efforts being made toward closer friendship between the engineering professions of the various countries are meeting with success. It was said also that a movement is on foot in England to organize the numerous engineering societies of the Empire into a federation similar to that which has been recently organized in this country.

Electric-Power Production for the First Four Months of 1921

The mean daily rate of production of electricity by public-utility plants during April, 1921, is the lowest since September, 1919, according to a recent report from the Geological Survey. The rate has been gradually decreasing since January of this year, although that is considered to be normal and usual at this time of the year, when longer hours of daylight cause less demand for current.

The figures for the mean daily output in kilowatt-hours for the first four months of 1921 are as follows: January, 114,200,000; February, 113,500,000; March, 109,800,000; April, 108,000,000.

The accompanying table shows other interesting figures for each month, the totals for the four months and the average for each month.

The Survey's report is based on returns received from about 3,200 power plants of 100-kw. capacity or more, engaged in public service, including central stations, electric railways and certain other plants contributing to the general supply.

MONTHLY TOTALS OF ELECRICAL PRODUCTION

The totals for the four months are also given, and from these the monthly averages are derived.

	Thousands of Kw-hr. produced by water and fuels.	Thousands of Kw-hr. produced by water power.	Thousands of Kw-hr. produced by fuels.	Short Tons of coal consumed.	Barrels of Fuel oil consumed.	Thousands of cu. ft. of natural gas consumed.
January....	3,541,493	1,342,689	2,198,804	2,984,154	897,088	1,707,413
February...	3,178,624	1,196,616	1,982,008	2,643,955	781,625	1,469,418
March.....	3,405,071	1,336,893	2,068,178	2,659,468	846,953	1,570,028
April.....	3,239,549	1,301,547	1,938,002	2,429,171	829,120	1,916,497
Total....	13,364,737	5,177,745	8,186,992	10,716,748	3,354,786	6,663,356*
Average..	3,341,184	1,294,436	2,046,748	2,679,187	838,696	1,665,839

*The figures for natural gas consumed include 284,994,000 cu.ft. of artificial gas used in Ohio.

F. B. Crocker, Noted Electrical Engineer, Is Dead

Francis Bacon Crocker, known as one of the most prominent men in the electrical industry and as one of the founders of the C. and C. Co. and the Crocker-Wheeler Co., of which he was director at the time of his death, died July 9 in New York City in his sixty-first year.

His standing in the electrical world is well brought out by the following statement from Thomas A. Edison, commenting upon his death:

Professor Crocker's death removes one of the outstanding pioneers of the electrical industry. His work and teachings as founder and head of the school of electrical engineering at Columbia University contributed much to the growth and importance of the electrical development of this country. As the first chairman of the standardization committee of the American Institute of Electrical Engineering, Professor Crocker's painstaking work earned the lasting gratitude of every one connected with the electrical industry throughout the world.

Professor Crocker was born and educated in New York City, having been graduated from the School of Mines of Columbia University in 1882. Later he founded the School of Electrical Engineering at the University and was head of that school for almost twenty years.

His most notable achievement was probably the development of the electric motor into a commercially practical device in 1886. At that time he was associated with Charles G. Curtiss and Dr. Schuyler S. Wheeler. He is also well known for his efforts to bring about complete standardization of electrical equipment throughout the world, and was one of the two American delegates to the International Electrotechnical Commission in London.

During the war he was an adviser to the members of the Naval Consulting Board and, with the aid of Cooper Hewitt, developed the first successful helicopter in this country.

He leaves a brother, Major David Crocker, and two sisters, Mrs. Henry C. Mortimer and Mrs. G. W. Kelly.

Isaac Harter New Superintendent of Babcock & Wilcox

Announcement has just been made that Isaac Harter, assistant to the president of the Babcock & Wilcox Co., has been appointed general superintendent of the company to succeed the late James P. Snedden. It may really be said that Mr. Harter has spent his entire life since his graduation from college with the organization that he now heads, for the only two companies with which he has worked, other than Babcock & Wilcox, were absorbed by that company. His appointment is, therefore, not surprising, but is of considerable interest on account of his notable activities in the boilermaking business.

Mr. Harter was born in 1880, in Mansfield, Ohio, and after going through St. Paul's School at Concord, N. H., attended the University of Pennsylvania. He was graduated in 1901 and immediately started in at the bottom with the Aultman & Taylor Machinery Co., of which his father had previously been president. His first job was in the boiler department as a gang boss on inventories, and later on he went into the cost department to learn more of the details of the business. While in this department he was elected a director of the company and a little later became acting superintendent of the boiler department.

In September, 1905, when this company sold its boiler business to the Stirling Co., Mr. Harter joined the staff of E. R. Stettinius, the Stirling Co.'s business head. In 1907 the Babcock & Wilcox Co. absorbed the Stirling Co. and Mr. Harter became superintendent of the Stirling works at Barberton, Ohio, as the successor of L. I. Summers. In 1911 he became superintendent of the Bayonne, New Jersey, works, where he remained until his appointment, about a year ago, as assistant to the president. His office was then established in New York City, where he is to remain as general superintendent of the company.

Mr. Harter's interest in gathering knowledge and sharing it with others has carried him into a number of engineering societies; he holds membership in the following: American Institute of Mining and Metallurgical Engineers, American Society for Testing Materials, Society of Naval Architects and Marine Engineers and American Society of Mechanical Engineers.

An idea of the great size and considerable importance of the American Society of Mechanical Engineers may be obtained from the following figures, which are corrected up to July 1, 1921: Number of members, 14,443; applications pending, 771; number of local sections, 48; number of student branches, 58; circulation of *Mechanical Engineering*, the journal of the society, 19,400.

Personals

Carroll F. Merriam has been appointed an instructor at Worcester Polytechnic Institute.

Philip W. Swain is now associate editor of *Power*, having left the Franklin Manufacturing Co., of Franklin, Pa.

Edgar MacNaughton, formerly assistant professor of mechanical engineering at Tufts College, Mass., has been made professor.

A. L. Jones, Jr., has been transferred from the Deane Works of the Worthington Pump and Machinery Corporation, at Holyoke, Mass., to the Kansas City office of the corporation.

L. W. Helmreich, previously with the Arkansas Corporation Commission, Little Rock, Ark., has been chosen chief mechanical and electrical engineer for the Missouri Public Service Commission, Jefferson City, Mo.

Hubert S. Wynkoop has been chosen by President Berresford of the American Institute of Electrical Engineers to represent the Institute in co-operating with the Building Codes Committee of the Department of Commerce.

S. W. Kohn, a recent graduate of the Case School of Applied Science as a Bachelor of Science in Electrical Engineering, has started in with the National Power Machinery Co., Cleveland, Ohio, as electrical engineer.

F. A. Darst has resigned as manager of the Williamson Power Co., at Clay Center, Kan., to take the same position with the Public Service Co. of Oklahoma, at Vinita. He was in the former position for a year, and before that was manager of the Beloit City Light and Water Co.

Charles V. McIntire has resigned as chief engineer of the International Coal Products Corporation to enter the field of consulting engineering in New York City. He will specialize in byproduct coke oven work, low-temperature distillation of coal processes and other systems involving the preparation and treatment of coal.

Charles E. Neil, editor of *Rate Research*, is now also the editor of the monthly bulletin of the National Electric Light Association. As editor of the *Bulletin* he succeeds H. M. Platt, who has become associated with the Society for Electrical Development. Mr. Neil was formerly rate expert for the Public Utilities Commission of Colorado at Denver.

Arthur J. Turner, formerly chief engineer for the Columbia Basin survey commission of the State of Washington, is now superintendent of construction on the Skagit River power project of the City of Seattle. Mr. Turner and C. F. Uhden, chief engineer of the Skagit project, worked together on the Long Lake dam and power plant of the Washington Water Power Co. and have gathered together quite a number who were their associates in that work.

Society Affairs

The Swedish Engineers' Society of Chicago has moved its clubrooms and library from 619 City Hall Square Bldg. to a new and spacious clubhouse at 503 Wrightwood Ave. A. Cederoth is the Secretary.

The West Virginia-Kentucky Association of Mine, Mechanical and Electrical Engineers will hold its next annual convention Sept. 20-23 in Huntington, W. Va. Meetings will be held in the Chamber of Commerce Building, in which there will also be the exhibits of the Coal and Industrial Exposition. The program will include committee reports on assigned subjects, lectures and general discussion. The secretary is Herbert Smith, 212 Robson-Pritchard Bldg., Huntington, W. Va.

The Pennsylvania Electric Association is to hold its fourteenth annual convention at Bedford Springs, Pa., Sept. 7-10 inclusive. There will be morning and afternoon sessions except on Saturday, when the final session will be held in the morning. The program will open Wednesday evening, Sept. 7, with the reception to the president. A paper on "The Superpower Survey as It May Affect Pennsylvania" will be read by Harold Goodwin, Jr., on Thursday morning. Sessions will be held by the Commercial, Technical and Accounting sections. Each evening the Westinghouse Co.'s band will give a concert at Pittsburgh, which will be reproduced at Bedford Springs by the radiophone. The chairman of the program committee is A. L. Atmore, 1000 Chestnut St., Philadelphia, Pa.

Business Items

The Sullivan Machinery Co., Chicago, Ill., is distributing Bulletin No. 78-A, describing its line of dry vacuum pumps. These pumps are made in both steam- and belt-driven models.

The Allis-Chalmers Manufacturing Co., Milwaukee, Wis., is sending out a new bulletin, No. 1115, describing its line of engine-type a.c. generators. A number of the photographs in the booklet show interesting views of constructional details.

The Fisher Governor Co., Marshalltown, Iowa, is distributing Bulletin No. 210, which describes the "Series 90" pressure-regulating valve. Some interesting suggestions and data are given for finding the correct size of valve to use under given conditions.

The Westinghouse Electric and Manufacturing Co., East Pittsburgh, Pa., has announced that F. T. Whiting, formerly manager of the engineering division of the Chicago office, has been appointed manager of the industrial division of that office to succeed N. G. Symonds, and that P. H. Smith has been appointed manager of the power division of the Atlanta office.

FUEL PRICES

BITUMINOUS COAL

The following table shows the trend of the spot steam market in various coals (mine-run basis, f.o.b. mines):

Coal	Market Quoting	July 5 1921	July 12 1921
Pool 1,	New York	$3.15	$3.00@3.15
Pocahontas,	Columbus	3.25	3.15@3.40
Clearfield,	Boston	2.10	1.75@2.35
Somerset,	Boston	1.90	1.65@2.10
Pittsburgh,	Pittsburgh	1.85	2.00@2.15
Kanawha,	Columbus	2.15	2.00@2.25
Hocking,	Columbus	2.15	2.00@2.25
Pittsburgh No. 8	Cleveland	2.20	2.15@2.30
Franklin, Ill.,	Chicago	2.90	2.25@3.50
Central, Ill.,	Chicago	2.40	2.00@2.75
Ind. 4th vein,	Chicago	2.50	2.25@2.75
Standard,	St. Louis	1.75	1.75
West Ky.,	Louisville	2.10	1.75@2.40
Big Seam,	Birmingham	2.25	2.00@2.25
S. E. Ky.,	Louisville	2.25	2.00@2.50

New York—On July 6, Port Arthur light oil, 23@25 deg. Baumé, 4¼c. per gal. 30@35 deg., 5½c. per gal. f.o.b. Bayonne, N. J.

Chicago—July 9, for 24@28 deg. Baumé, 40@50c. per bbl.; 32@34 deg. 1¼@1½c. per gal. in tank cars f.o.b. Oklahoma refinery, or freight adjusted.

Pittsburgh—On June 20, f.o.b. refinery; Pennsylvania, 36@40 deg., 3¾c. per gal.; Oklahoma, 24@30 deg. 35c. per bbl., gas oil, 32@34 deg., 1¾c. per gal., 36@38 deg., 2¼c. 38@40 deg. 2¾c.

St. Louis—July 9. prices f.o.b. cars, tank lots; 24@26 deg. Baumé, 35c. per bbl.; 26@28 deg., 35c.; 28@30 deg. 40c.; 32@34 deg. 1¾c. per gal.

Philadelphia—On June 20, 26@28 deg., Baumé, Oklahoma, 3¼c. per gal.; 30@34 deg., Oklahoma (group 3) 2¾c. per gal.

Cincinnati — June 27, for 22@28 deg. Baumé, 6½c. per gal.

Cleveland — June 27, for 22@28 deg. Baumé, 5c. per gal.

New Construction

PROPOSED WORK

N. Y., Brooklyn—The Park Land Co., c/o Springsteen & Goldhammer, 32 Union Sq., Archts., plans to build a 6 story apartment at 107 Eastern Parkway. About $250,000. Work will be done by day labor.

N. Y., Elmhurst (Flushing P. O.)—The Queensboro Lodge No. 878, B. P. O. E., Bway., is having plans prepared for a lodge building on East Queens Blvd. near Grand St. About $500,000. Ballinger Co., 47 West 34th St., New York City, Archt. and Engr.

N. Y., Flushing, L. I.—The Long Island Theater Corp., 116 West 39th St., New York City, plans to build an 88 x 136 ft. theater building on Bway. near Main St. About $400,000. Architect not yet selected.

N. Y., New York—The 244 West 74th St. Corp., 377 Bway., plan to build a 9 story apartment on West 74th St. About $300,000. G. F. Pelham, 200 West 72d St., Archt. and Engr. Work will be done by day labor.

N. Y., New York—Broadway & Hamilton Place Corp., c/o H. J. Krapp, 116 East 16th St., Archt., plans to build a theater and store building at 138th St. and Bway. About $600,000. Work will be done by day labor.

N. Y., New York—The Echo Park Constr. Co., Inc., c/o Shampan & Shampan, 50 Court St., Brooklyn, Archts., plans to build a 5 story apartment house including a steam heating system on the Grand Concourse and Echo Pl. About $250,000. Work will be done by day labor.

N. Y., New York—Ezra Holding Co., c/o C. Kreymborg, Archt., 2534 Marion Ave., will soon receive bids for a 6 story, 100 x 100 ft. apartment on the Grand Concourse near Fordham Rd. About $250,000.

N. Y., Kew Gardens, L. I. (Jamaica P. O.)—The Kew Court Corp., c/o L. V. V. Sweezy, Archt., Bible House, New York City, plans to build a 4 story, 125 x 200 ft. apartment house on Metropolitan Ave. About $300,000. Work will be done by separate contracts under supervision of archt.

N. Y., Lancaster—The Bd. Educ. plans to build a high school. About $250,000. M. C. Miller, 80 West Genesee St., Buffalo, Archt.

N. Y., New York (Manhattan Boro.)—Irving Margon, Archt. and Engr., is having preliminary plans prepared for a 6 story, 170 x 200 ft. apartment house on Kingsbridge Rd. and the Grand Concourse. About $500,000. Owner's name withheld.

N. Y., New York (Manhattan Boro.)—I. Polstein, 280 Madison Ave., is having plans prepared for an 11 story, 95 x 125 ft. apartment house, here. About $800,000. G. F. Pelham, 200 North 72d St., Archt. and Engr.

N. Y., Springville—The town voted $100,000 bonds for constructing dam for electric power supply.

N. J., Jersey City—The St. Joseph's Orphanage, c/o W. Neumann, 314 Palesade Ave., Archt., will soon award the contract for an orphanage. About $500,000.

N. J., Millville—The Bd. Educ. plans to build a 2 or 3 story high school, including a steam heating system on High St. About $300,000. Architect not yet selected.

N. J., Trenton—The Bd. Educ. plans to build a 2 story Junior high school. About $500,000. W. Poland, 9 South Stockton St. Archt.

Pa., Latrob—The Pearce Mfg. Co., plans to remodel boiler plant, including rebuilding boiler house, replacing present boilers and the installation of a complete high pressure piping system. J. Breslove, Oliver Bldg., Pittsburgh, Consult. Engr.

Pa., Roanoke — The American Viscose Co., Marcus Hook, is having preliminary plans prepared for a silk plant, including a steam heating system. About $1,000,000. The Bollinger Co., 105 South 12th St., Philadelphia, Archt. and Engr.

D. C., Wash.—The Hamilton Hotel Corp., 4th and K Sts., is having plans prepared for a hotel. About $2,000,000. J. H. De Sibour, Hibbs Bldg., Archt.

W. Va., Morgantown—The University of West Virginia is having plans prepared for a physical education building. About $300,000. Paul A. Davis, 3d., 1713 Sonsom St., Archt.

N. C., Goldsboro—The N. C. State Hospital for Insane, is having plans prepared for buildings, including a heating plant; power house, etc. About $300,000. R. G. Ball, 316 East Lane St., Raleigh, Engr.

Miss., Magee—T. C. Link, supervising archt., Dir. Pub. Wks., P. O. Box 636, Jackson, will receive bids until August 8 for several buildings, including power house at the tuberculosis sanitarium. B. Price, Jefferson County Bank Bldg., Birmingham, Ala., Archt.

O., Lowell—The City of Marietta plans election in August to vote on $500,000 bonds to build a hydro-electric plant here. H. Gamper, New 1st Natl. Bank Bldg., Columbus, Engr.

O., Martins Ferry—City is having preliminary sketches made by H. Gamper, Engr., New 1st Natl. Bank Bldg., Columbus, for an electrical plant along the Ohio River. About $500,000.

O., Painesville—The City will soon award the contract for a 60 x 118 ft. power plant. About $75,000. Watson Engineer Co., 6414 Prospect Ave., Cleveland, Engr. Bids will be taken later on equipment.

O., Shaker Heights—The Bd. Educ. is having plans prepared for a 3 story high school at Woodland and Woodbury Rds. About $400,000. C. W. Bates, 604 Marshall Bldg., Cleveland, Archt.

Ill., Chicago—A. Flower, c/o Roosevelt State Bank, 35th and Grand Blvd., is having plans prepared for a 3 story, 100 x 205 ft. theater, stores and office building, including a steam heating system. About $450,000. A. Anis, 139 North Clark St. and Z. E. Smith, 305 East 55th St., Associate Archts.

Ill., Chicago—J. S. Miller, 38 South Dearborn St., is having plans prepared for a 21 story, 92 x 123 ft. office building, including a steam heating plant on Michigan Blvd. and Plaza. About $2,000,000. A. S. Alchuler, 28 East Jackson Blvd., Archt.

Ill., Chicago—The Tooker Storage & Forwarding Co., 1400 South Clark St., is having plans prepared for a 6 story warehouse, including a steam heating system on Lumber St., at Chicago River. About $500,000. G. C. Nimmons & Co., 122 South Michigan Blvd., Archts.

Ill., Edwardsville—F. J. Arbe, Engr., Ry. Exch. Bldg., St. Louis, Mo., will receive bids until July 21 for addition to power house, here, for N. O. Nelson Mfg. Co., 928 Chestnut St., St. Louis, Mo. W. H. Baker, Secy. About $30,000.

Ill., Flora—The City will soon award the contract for a 40 x 60 ft. addition to its electric light and power house. About $25,000. Fuller & Beard, Chemical Bldg., St. Louis, Mo., Engrs. Noted June 14.

Ill., East St. Louis—The East St. Louis School Dist. plans to build a school. About $350,000. Architect not selected.

Wis., Milwaukee—H. Marggroff Co., 964 10th St., plans to build a 7 story apartment house at 264 Prospect Ave. About $300,000. M. Tullgren & Sons, 425 East Water St., Archts.

Wis., Milwaukee — The Marquette University, 115 Grand Ave., having preliminary plans prepared for a power and heating plant. E. Brielmaier & Sons, 432 Broadway, Archt. and Engr.

Wis., Milwaukee—M. Tullgren & Sons, 425 East Water St., will soon award the contract for a 7 story, 70 x 62 x 80 ft. apartment house on Prospect Ave. About $300,000. Noted June 21.

Wis., Watertown—The Chamber of Commerce plans to build a hotel. About $300,000. G. F. Keck, 67 East Oak St., Chicago, Ill., Archt.

Wis., Edgerton — The Highway Trailer Co., plans to build a 1 story, 180 x 900 ft. assembling plant. About $200,000. Architect not selected.

Wis., Madison—Three-F Laundry Co., 731 East Dayton St. is receiving bids for addition to laundry and plans to install motors. About $40,000. F. S. Kronenberg, Slichter Bldg., Archt.

Wis., Shorewood (Milwaukee P. O.)—The School Bd., J. E. Williams, Clk., will receive bids until July 25 for a 2 story school addition and heating plant on Atwater Rd. About $225,000. R. Messmer & Bros., 221 Grand Ave., Archt.

Wis., Waukesha—The Manitoure Church Furniture Co., c/o C. F. Schuetze, Gen'l. Mgr., Lincoln Ave., plans to build a power house and install a 125 kw. engine and generator set. Engineer not selected.

Ia., Bellevue — The Henry G. Johnson Piano Co. plans to build a 1 story, 80 x 600 ft. factory, including a steam heating system. About $1,000,000. Work will be done by day labor.

Ia., Dubuque — The Federal Deposit & Trust Co., 972 Main St., plans to build an 8 story bank and office building. About $300,000. Architect not selected.

Minn., Faribault—The St. Lucas Hospital, T. Kettelhut, Supt., will soon award the contract for a 4 story, 44 x 101 ft. hospital including boiler house and laundry. About $150,000. Schippel & Schmidt, Kruss Bldg., Mankato, Archts.

Minn., Virginia—The Bd. Educ., c/o J. R. McGhee, Clk., will receive bids until July 26 for a 3 story school including a steam heating system. About $300,000. Kelly & Schefchik, 1006 Alworth Bldg., Duluth, Archts. Noted Jan. 18.

Neb., Omaha—The Bd. Educ, c/o W. E. Burke, Secy., City Hall Bldg., will receive bids until July 28 for a 4 story, 210 x 240 ft. high school including a steam heating system. About $2,000,000. F. W. and E. Clarke, 640 Paxton Block, Archts.

Mo., Linn Creek—J. B. Ouigler, Lebanon, plans to build a power plant and dam across Niaggua River. About $100,000. Engineer not selected.

Mo., Neosho—C. E. Prettyman, Mayor, is in the market for a steam engine and rock crusher.

Mo., St. Louis — The Federal Reserve Bank, Bway. and Pine St., is having plans prepared for a 10 and a 14 story bank building, including a steam heating system on Locust St. and Bway. About $2,000,000. Mauran, Russell & Crowell, Chemical Bldg., Archts.

Mo., St. Louis—The Sisters of St. Mary, 1536 Papin St., will soon award the contract for a 7 story, 160 x 280 ft. hospital including a steam heating system on Belleview Ave. and Clayton Rd. About $1,000,000. A. B. Groves, Stock Exch. Bldg., Archt. Noted March 15.

Mo., St. Louis—The Woodward & Tierman Printing Co., 309 North 3d St., plans to build a 2 and 3 story factory, including a steam heating system. About $1,000,000. Architect not selected.

Mo., St. Louis—The Missouri Pacific R.R., c/o Dr. Vasterling, California and Eads Sts., will receive bids until July 24 for a 6 story, 100 x 200 ft. hospital on Grand and Shaw Sts. About $450,000. C. H. Wray, Rialto Bldg., Archt. Noted July 12.

Mo., St. Louis—Chas. Ulman, 4540 Lindell St., plans to build an 8 story, 195 x 230 ft. hotel including a steam heating system at Kingshighway and Lindell St. About $4,000,000. W. J. Knight Engr. Co., Wainwright Bldg., Engr.

Mo., Wellsville — The City, c/o Mayor Heckart, plans to install a pumping station. About $40,000. Engineer not selected.

Okla., Broken Bow—Hugo Hydro Electric Power Co., Hugo, plans to build 3 dams on the unit plan. Mountain Fork Dam (first to be contructed), 200 ft. high, estimated 125,000 hp., Little River Dam, 200 ft. high, 75,000 hp. and Kiamichi River Dam, 100 ft. high, 50,000 hp., 10 mi. northeast of here. W. L. Larimore, secy. Engineer not selected.

Okla., Oklahoma City—The Curtiss Booth & Bentley Co., 701 Main St., plans to build a 2 story planing mill including a steam heating system. About $500,000. Architect not selected.

Okla., Picker—The City plans to lay new water-mains and install an air lift pump. About $25,000. Engineer not selected.

Que., Bagotville—The Town Council—L. P. Chafer, Secy., is in the market for complete equipment for hydro-electric plant. About $25,000.

Ont., Hamilton—R. H. Foster, Secy. of the Bd. Educ. will receive bids until July 18 for a 4 story main school building with 3 additional wings, including a steam with electric driven mechanical ventilation system on Wentworth St., N. About $800,000. Witton & Walsh, Hamilton Provident & Loan Bldg., Archts.

Que., Montreal—Laporta Martin & Co. Ltd., 584 St. Paul St. West, H. H. Laporte, Purch. Agt., is in the market for two 35 hp. electric motors.

Ont., Port Burwell—The Council, c/o G. A. Vanorder, plans to build an electric lighting and power distribution plant here.

Ont., St. Catharine—The Bd. Educ., C. A. McBride, Secy., 13 Welland Ave., plans to build a 3 story collegiate building on Geneva St. About $600,000. Architect not selected.

Ont., Timmens—H. E. Montgomery, Clk., will receive bids until July 22 for an electric motor and blower with complete electric fixtures for an activated sludge sewage plant. J. F. Henderson, Eng.

CONTRACTS AWARDED

Mass., Boston — The Boston Lying-In Hospital, 24 McLean St., has awarded the contract for a 4 and 5 story, 43 x 173 ft. main hospital building with two 3 story, 32 x 36 ft. wing additions on Longwood Ave. to Whidden & Berkman Co., 80 Boylston St. About $300,000.

N. Y., New York (Manhattan Boro.)—Slawson & Hobbs, 162 East 72d St., will build a 5 story, 90 x 100 ft. apartment house on Dyckman St. and Sherman Ave. About $300,000. J. M. Felson, 1133 Bway., Archt. and Engr.

Fla., Moore Haven — The City has awarded the contract for an electric plant to Fairbanks Morse Co., 900 South Wabash Ave., Chicago, Ill., about $19,285.

Pa., Jeanette—The Bd. Educ. has awarded the contract for a 2 story, 125 x 225 ft. school to the Standard Constr. Co., 1713 Sanson St., Philadelphia, at $254,500.

O., Akron—The Commodore Perry Hotel Co., c/o B. A. Shriber, has awarded the contract for a 10 story, 132 x 251 ft. hotel and theater building including a steam heating and refrigerating system, to the George A. Fuller Co., Swetland Bldg., Cleveland. About $2,000,000. Noted May 10, 1921.

O., Cleveland—The Noble Refining Co., Bessemer Ave. and East 87th St., has awarded the contract for a 1 story boiler house factory, to the Girard Constr. Co., The Arcade, at $75,000.

Mich., Adrian—Utility Compressor Co., 1161 East Harper Ave., Detroit, has awarded the contract for a 1 story factory, on Treat St. to Delisle & Cooper, 402 Ford Bldg., Detroit. Electric motors will be installed. About $40,000.

Mich, Detroit — The Dept. of Parks & Blvds., 602 Marquette Bldg., has awarded the contract for furnishing mechanical and electrical equipment including electrically operated pumps, lighting equipment, etc., for the Scott Memorial Fountain on Belle Isle, here, to the Pittekow Heating and Eng. Co., 312 West Larned St., at $75,785.

Wis., Two Rivers—The City, c/o City Clerk, has awarded the contract for equipment for switchboard and electric distribution system, to the Greusel, Quarfot Electric Co., 23 Erie St., Milwaukee, at $25,000.

Ia., Arnolds Park—The city has awarded the contract for an 8 x 14 ft. pump house and 100 ft. tower with 30,000 gal. steel tank, to the Waite Eng. & Constr. Co., Minneapolis, Minn., at $26,920. Noted June 21.

Kan., Lawrence—The University of Kansas, has awarded the contract for a 4 story, 100 x 180 ft. union building to A. R. Stimson, 1516 Boswell St., Topeka. About $500,000. Noted May 10.

Neb., Omaha — The World Realty Co., 1410 Farman St., has awarded the contract for a 5 story, 110 x 132 ft. theater, including a steam heating system, on the Northwest corner of 5th and Douglas Sts., to James Black, 3545 Harney St. About $500,000. Noted June 28.

Minn., Minneapolis—The Bd. Educ. has awarded the contract for the installation of a heating and ventilating system in the proposed 2 and 3 story Jordan Junior High School on 295, North and James Ave., to H. Kelly & Co., 925 Plymouth Bldg., at $60,542. Noted May 17.

Ont., Guelph—The Ontario Agricultural College has awarded the contract for a 2 story veterinary college including a steam heating system to Schultz Bros., Brantford. About $271,500.

Ont., Petrolia — The Canadian Oil Co., Ltd., Excelsior Life Bldg., Toronto, has awarded the contract for a power plant addition, including seven 150 hp. steam horizontal boilers; 1 story, 40 x 80 ft. boiler house and a 1 story, 30 x 50 ft. pump house, to John Ingles Co., Ltd., 14 Strachan Ave., Toronto, at $35,000.

Ont., Toronto—The Toronto Skating Club, c/o Lt. Col. A. E. Kirkpatrick, Excelsior Life Bldg., has awarded the general contract for a 1 story skating rink including a steam heating system and artificial ice equipment, on Dupont St., to H. N. Dancy & Son, 22 College St., at $105,000. Noted May 3.

Alaska, Sitka—The Bureau of Yards and Docks, Navy Dept., Wash., D. C., has awarded the contract for two 300 foot steel radio towers and erection of one 200 ft. Guyed Tubular Mast U. S. N. Radio Station, to the Hurley-Mason Co., 14 North Muir St., Seattle, Wash., at $22,220.